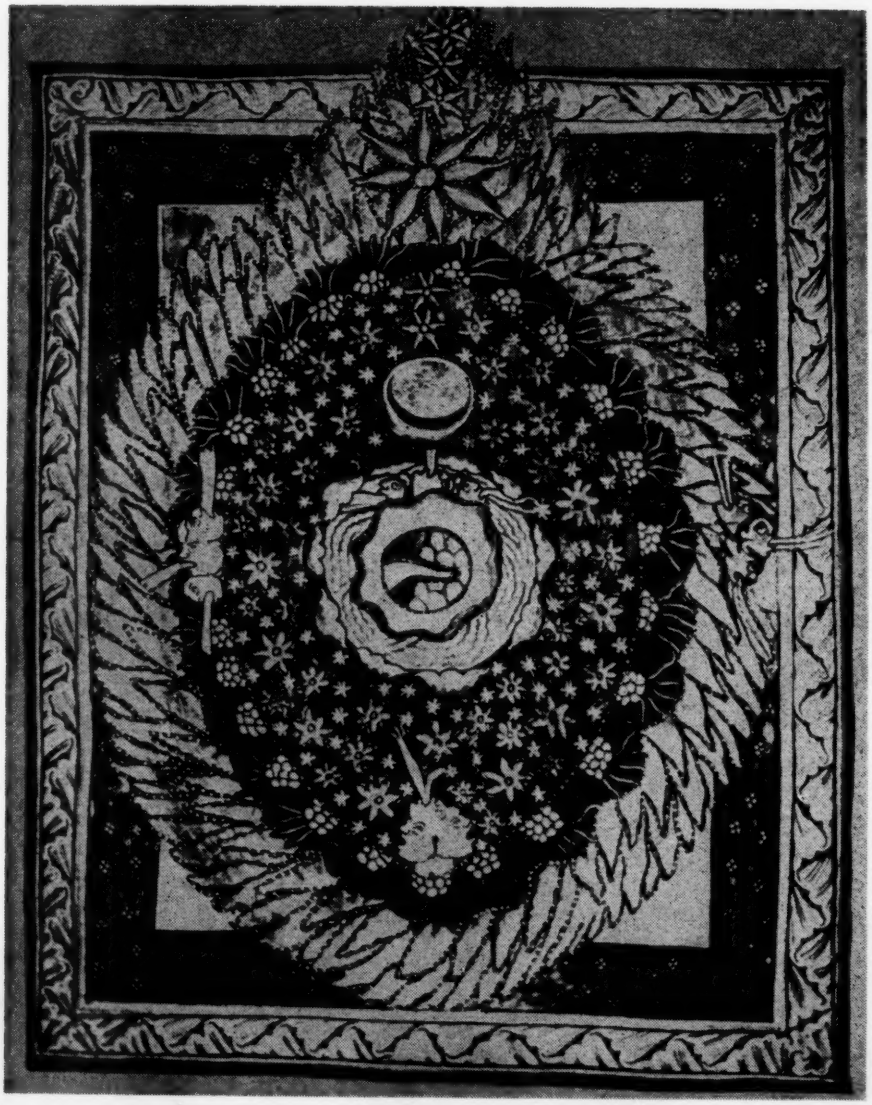
MAIN CURRENTS

IN MODERN THOUGHT



Kosmos

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MAIN CURRENTS IN MODERN THOUGHT

A co-operative journal to promote the free association of those working toward the integration of all knowledge through the study of the whole of things, Nature, Man, and Society, assuming the universe to be one, dependable, intelligible, harmonious.

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CONTENTS

C. G. Jung's well-known work with psychological patients led, in many cases, to certain final designs, often of considerable beauty. These he recognized to be of the nature of the *mandalas* of Indian, Tibetan and Chinese art, works which embody the serenity of quiet minds. The cover illustration may be taken as an example of similar psycho-aesthetic expressions, numerous in mediaeval Christianity.

The illustration, entitled "Kosmos," comes from a 12th Century manuscript (now in the Wiesbaden Library), *Scivias* from *Scito vias Domini*, "Now the Ways of the Lord." The author, Hildegard von Bingen (b.1099, d.1179) describes the illustration. Her visions are recorded in the manuscript, allegorical world images of the kosmos, and of the microcosm, relating the order of the known world to the divine unknown. The cosmological details, allegorical in their meaning, including the concept of the sphere (here elliptical), of the various celestial and earthly lights, the sun as the burning love of Christ, the three stars as representative of the planets and also as embodiments of the Trinity, the inclusion of the Elements, are all evident. The illustration shows the intermingling of scientific notions and religious intuitions characteristic of mediaeval thought.

We are indebted to Professor H. Bober of the Institute of Fine Arts of New York University for access to this material.

MAIN CURRENTS IN MODERN THOUGHT is published 5 times a year in Sept., Nov., Jan., March, and May, to call attention to significant contributions to learning currently being made by workers in the multiple fields into which knowledge has come to be classified. It relates these advances to each other and to the classical and contemporary views of Eastern, European and American thinkers. It is designed to save time for the reader by providing a vantage-ground from which the whole world of knowledge may be surveyed and kept in proportion as it moves toward integration. Its editors assume that the principles of art, the universals of philosophy, the laws of Nature and Man as formulated by science, and the truths of comparative religion, can be orchestrated into a harmonic, meaningful, ethical body of teachings which can and should be made the central core of curricular study in the educative process at all levels of development. In condensing text, square brackets [ ] indicate editorial interpolation. Three dots . . . in the text indicates a word, phrase or passage omitted in the interest of brevity or clarity. Other usages are standard. $3.00 a year. Foreign $3.50. Contributors to MAIN CURRENTS enjoy full liberty of opinion and expression in these pages. *Entered as second class matter April 13th, 1946, at the post office at Port Chester, New York, under the Act of March 3rd, 1879. (Reentered as second class matter November 17th, 1953, at the post office at Port Chester, New York, under the Act of March 3rd, 1879.)*

SCIENCE AND RELIGION*

C. A. Coulson, F. R. S.

Oxford University

The Evolution of an Historic Conflict

It will seem strange to many that when titles were being chosen for our evening discourses, the topic "Science and Religion" should have been considered. In view of the famous acrimonious debates of the past on the whole issue of science and religion, I want to look dispassionately at some of these conflicts, and try to discover the real motivating influences behind them. These influences were often disguised by the manner of the debate. This will lead us to ask just what the two sides were defending, and will help us to see that, in their way, they were both right to make such a defense. But neither side can rest indefinitely in the stalemate which has characterized their mutual relationship for the last fifty years. Indeed new discoveries, carrying with them a new outlook, seem to me to have led us to a new position in which what is true and best in both camps should be found acceptable to the representatives of either party. So before I finish I shall want to say where I think all this is leading us, and refer to a sense of urgency which we dare not reject from all our discussions of these things.

Many people have the impression that science and religion have always been at loggerheads. Nothing could be further from the truth. If we want to trace the background in which the conflict developed, we shall find that the first phase was one of cooperation, and not mistrust. It was assumed that science fitted in with religion, and would lead from the daily experiences of the laboratory to the awe and wonder of faith. The more we understood the world that God made, the fuller and more natural would our worship be.

But even in those earliest days there were rumbles of what later became a thunderous discord. At the time when the [British] Association [for the Advancement of Science] was founded, James Hutton had been dead for a mere thirty-four years; and thanks to his pupil John Playfair, his ideas of the development of the earth's crust, carrying with it a time-scale vastly different from that generally accepted on the basis of the early chapters of Genesis, were gaining credence. The president at our first Oxford meeting in 1832 was William Buckland, professor of geology here and canon of Christ Church. In his Bridgewater treatise he threw overboard the traditional dating of the earth, and accepted the impossibility of a literal reconciliation with Genesis. He was violently attacked, and the battle was joined.

This was not the only dispute; nor was it the most famous. Charles Darwin's *Origin of Species* was published in 1859, with its claim that biological species are not fixed, but develop gradually in accordance with the conditions most suitable for survival. His book dealt only with the lower animals, but he did allude to the application of his ideas to human evolution. As might be expected, the publication of the *Origin* was the occasion for much enthusiasm and much execration. Scientists were by no means unanimous among themselves.

This was the situation when, at the end of June, 1860, our Association met again at Oxford. Darwin himself was not well enough in health to attend, much less to speak. But Huxley and Hooker were there, and with Owen and his friend Samuel Wilberforce, Bishop of Oxford, on the other side, the scene was set for what is possibly the most famous public meeting ever to be held in this city. The Bishop in the *Quarterly Review* had declared that "the principle of natural selection is absolutely incompatible with the word of God," and his followers had thun-

* Condensed from a discourse delivered at Oxford on September 5, 1954, during the Annual Meeting of the British Association, and published in the December, 1954 issue of *The Advancement of Science.*

dered a score of other denunciations after him. "Evolution was an attempt to dethrone God"; if its thesis were true then "Genesis is a lie . . . and the revelation of God to man, as we Christians know it, is a delusion and a snare." Now, at this meeting, he proceeded to "spout for half an hour with inimitable spirit, ugliness and emptiness and unfairness," but he made a fatal mistake. Turning to Huxley he sarcastically enquired whether it was through his grandfather or his grandmother that he claimed descent from a monkey. After that, Huxley himself whispered to the person sitting at his side—"The Lord hath delivered him into mine hands."

The third famous struggle followed almost inevitably from the others. I refer to the doctrine of freewill. Less than fifteen years after the Darwin episode, Huxley rejected freewill as irrelevant to the behavior of animals, stating that thought was a by-product of the brain, and decision merely an apparent activity. At the same time Tyndall was no less definite: "We claim, and we shall wrest from theology, the entire domain of cosmological theory." Matter indeed seemed the only thing that was important. "Divorced from matter, where is life? Whatever our faith may say, our knowledge shows them to be indissolubly joined."

This, then, is the second stage of our story—the coming in of alternative views to the traditional religious ones, and the gradual widening of the area of conflict as one by one new discoveries were made in different fields of science. The Church was divided, but all too often it tried to establish hedgehog positions. It was inevitable that those who sought to entrench themselves in this fashion should ultimately be forced to retreat. As Sir James Frazer puts it: "From one department after another the gods are reluctantly, or contemptuously, dismissed." It must have seemed to many that in proportion as the geologist understood the structure of the earth and its rocks and stones, the engineer controlled the sources of power, the anatomist related thought to the pattern of electrical impulses within the brain, the psychologist knew men's instincts and emotions, the geneticist his hereditary make-up, the physiologist his chemical needs, and the biologist painted some picture, however faint, of the whole evolutionary process, so God became unnecessary, a hypothesis for which there was no further use.

Before we come to the third stage of our story it may be well to try to understand a little more of the effective factors in this second stage. There must have been some valid basis for which they were fighting. If we can once understand this basis, then I believe the whole story falls together, and we can see where the third stage of the development is likely to lead us.

Putting it in its simplest terms the two parties were fighting for the right to make a pattern out of certain of their experiences—a pattern which would be coherent, meaningful and render unnecessary any other pattern. This, you may say, is elementary. So it is, but I am more and more convinced that it is central.

Let us think of it first from the point of view of the scientist. He was trying to make sense out of certain aspects of his experience. His pattern was built round concepts, in the last resort unprovable. When he said that a scientific theory was true, he meant that all the measurements he could make at present were by this theory fitted into a wider scheme, and caused no inconsistency in the fitting. Whether the models that he invented were really true—that was irrelevant. When Newton wrote that "God in the beginning formed matter in solid, hard, impenetrable, moveable particles," there are no grounds for supposing that he meant it in an entirely literal sense. What he wanted them for was as convenient concepts. These little particles were a framework on which the behavior of earths and moons and falling stones could be exhibited in such a fashion that it made sense. It was Newton's greatness that he could himself invent these impenetrable moving particles: for they were his creation, not God's.

This situation is typical of other branches of science also. Each one of us, as a scientist, is building a pattern. And the criteria which must be satisfied are that the pattern shall be coherent and meaningful. This is so important, and yet so often unrecognized, that I would like to illustrate it.

During the last thirty years enormous progress has been made in our understanding of the age of the universe. If, for the moment, we accept the view that long ago there was one rather unique moment of time, then a tremendous amount of evidence all seems to be converging on the value of about six thousand million years for the period that has elapsed since that particular event. At that time it seems that the whole universe was concentrated in an exceedingly small region, from which it has subsequently been continuously expanding. It is a tantalizing project to discuss the early stages of this expansion, and several distinguished physicists have tried their hands at it. In the latest of these, associated with the names of Gamov, Herman, Alpher and Hayashi, an attempt is actually made to describe the behavior of the primitive stuff of the universe following a period as short as one ten-thousandth of a second after zero-hour. It seems that whereas our present stage of evolution is one characterized by a preponderance of matter over radiant energy, in those earliest moments almost everything was radiation. Until the universe was five minutes old its temperature would appear to have been at least a thousand million degrees, so high that matter would almost wholly convert itself spontaneously into radiation. But by the end of half an hour this temperature would have fallen sufficiently for matter to become dominant, and for radiation increasingly to turn into protons and neutrons. Within an hour or so the genesis of the elements, light and heavy, would be practically complete.

The amount of detail in all this is frightening. And it all forms a thrilling pattern. Yet there is not one single aspect of it which can conceivably be tested experimentally. The very nearest that we can get is to invoke some metaphysical notion of the Uniformity of Nature, and try to reproduce tiny elements of the great pattern millions of years afterwards in one corner of that same wide universe. The meaning, the coherence, the satisfaction all lie in the concepts—and these, from the nature of things, are unprovable.

In the famous phrase of Kant, scientists are not really discussing "things-in-themselves," but merely concepts which represent them to us, and with which we can operate, to order and classify experience. Such at any rate is the account that people like Poincaré and Ernst Mach of the nineteenth century and Pierre Duhem of the twentieth century, have given. Any outside influence, or vested interest, anything which might interfere with, or detract from, or even compete with, his scheme of concepts, was bound to be anathema to the scientist. Hence his almost instinctive jump away from organized religion, and at the same time his strong left-wing tendencies in politics.

This leads us to ask what we can say about the Christian. Surely, that he too has his concepts—he speaks of good and evil, of purity and sin, of an indwelling spirit and a personal saviour. Not one of these concepts is strictly provable, and we must judge them by the cogency of the whole pattern they form. Here is Martin Luther, in his Commentary on the Book of Daniel, telling us what is a real and true conception of God: "A God is simply that whereon the human heart rests with trust, faith, hope and love. If the resting is right, then the God is right; if the resting is wrong, then the God, too, is illusory." A scientist could hardly hope to put his grounds for belief in science and scientific concepts more succinctly.

We can see why Bishop Wilberforce was worried. Putting it in the way that I have it was inevitable that a clash of this kind should occur, and equally certain that it would rest on misunderstandings. The sets of concepts are, after all, concepts: they operate only within their own boundaries; they can only clash through one or both of the parties failing to see what their concepts really are. So the excellent Professor Tyndall was simply beating the air when he boasted the claim of science to "wrest from theology the entire domain of cosmological theory." He could not possibly hope to wrest this back from theology for the simple reason that it had never truly been there. As for his discussion of matter and life, "matter" is a concept with which we operate within certain fields of discourse. If his particular concept of matter is that it represents "that mysterious thing" by which all growth, etc. is accomplished, there is nothing more to be said, except perhaps quietly to remind him that the concept is his, so that other people who do not share his particular predilections in this respect must be granted the right to other concepts of matter.

Anyone who doubts all this may reflect for a moment upon the way in which physics itself is absolutely riddled with apparent equivocations. Thus we work both with geometrical and wave optics; we treat electricity as sometimes a continuous flowing substance and sometimes as a discontinuous flow of electrons and even of holes; we assert that heat is a form of kinetic energy, but we set up equations for the flow of heat just as if it were the old-fashioned substance caloric. We have grown so used to all this that no one bothers much about it. What—to return to the second stage of our main theme—was most unlikely to happen in the early stages of the growth of modern science was that we should be big enough mentally to carry the same process which we accept within one discipline, into the wider domain of the relation between the separate disciplines. If only the Christians of the nineteenth century had had the imagination and elasticity of mind to see that the new patterns of science could answer just as well, and, at the same time, just as incompletely, to the question, "do the concepts do justice to the situations they describe?"; if only the scientists, in their terrific excitement about the wonders that their discoveries were revealing, could have paused to reflect that there might be alternative patterns to their own; it might have been possible to avoid a conflict. Even now neither side seems able to do this easily.

What those former Christians should have done when they were worried about the rival claims of the newer science, was to ask whether their own particular concepts did or did not do justice to the whole history of Christian behavior. I believe they would have found it true then, as I believe it to be true now, that no one who looks fairly at a reasonable sample of actions which claim a religious sanction, can honestly affirm that they do not match the beliefs out of which they spring. The daily life of thousands of people, unknown by name and humble in their living, extending in an unbroken tradition for two thousand years, convinces me that when they say that it is God working through them, I have neither the right nor the knowledge to reject their testimony. The concepts are validated because they do indeed do justice to the richness of life associated with them. And all this is entirely independent of whether any other interpretation may or may not be possible.

We are now ready to pass to the third stage of our story. The second stage—of conflict, followed by a gentlemen's agreement that neither the religious party nor the scientific party would interfere too openly in the affairs of the other—could not last. At best it could only be regarded as provisional; at worst it could be maintained only by a wilful blindness and a refusal to face certain rather tiresomely awkward questions. In the last fifty years it has become impossible to escape some of these latter questions.

The change has been most pronounced in the field of science. Several discoveries have been made about

the way in which science works; some of these appear quite disconcerting, at first. For example, it has always been well-recognized that in its attempt to describe and to understand nature, science has had to simplify a very complex situation. Such a simplification was possible in the old days. But as science grew and took into itself more and more of the totality of human experience it became difficult to continue this policy. In the earlier framework it was quite proper for Heisenberg to say that the concept of a "soul" finds no place in pure physics. But one of the most interesting problems which have been thrown up by modern physics is the question of the distinction between observer and observed. If we start with the naive assumption of an external world existing independently of ourselves, and consider carefully the way in which our awareness of it is bound up with the processes of observation and measurement and interpretation, we find that we can never clearly separate ourselves from the results of our measurements. If it is true, as Professor Frisch has put it, that when we ask a question of nature, she will respond by being altered, by soever little, then nature and man share an unsuspected intimacy. Seen in this way there is no hope of ever fulfilling Helmholtz's claim that "the final aim of all natural science is to resolve itself into mechanics." For in the last resort there can be no such thing as physical science distinct from biological science. All science is biological, however little it appears to resemble what we conventionally mean by that phrase.

But there are other developments too. As Professor Polanyi has pointed out, there is ultimately no such specimen as a "lone scientist." For even the most remote worker belongs to the scientific community, inherits its traditions, learns its methods, conforms to its basic ethos and spirit, accepts and builds on the work of others, even as he himself hopes his work may be the ladder on which his successor climbs. We speak of "schools" of science in our universities, and trace the manner in which the personalities of great men are impressed upon their followers. We notice how even in mathematics there are classical and romantic epochs, reflecting a relationship to the wider community. I have just said that all science is biological; I now must add that it is social.

Even this is not all. People have asked about the processes of the imagination which are involved in scientific effort, and have sought to comprehend its appeal to those who practice it. This is not easy. Yet I recall that Max Planck could say that "science was a created work of art: for new ideas are not generated by deduction, but by a creative imagination." And that when Jacobi was being reproached by Fourier for not spending enough time on the solution of certain rather practical problems in the conduction of heat, he replied: "It is true that M. Fourier has the opinion that the principal aim of mathematics is public usefulness, and the explanation of natural phenomena; but a philosopher like him should know that the sole end of science is the honor of the human mind." These are great words, and we might hesitate to apply them too directly to ourselves. But I imagine that we should all admit that we found in science something that satisfied and fulfilled a part of ourselves. At least we can say that we do science because we like it, and discover a thrill at the progressive understanding of the natural order in which we cooperate. To many among us it will not seem out of place to speak of this sense of given-ness as a revelation. Here, for example, is Etienne Gilson, the Canadian philosopher, writing about this very situation, that "such is the true reason why, far from keeping away from science, a truly religious mind should do its utmost to follow it in its progress, as the most perfect homage rendered by nature to its creator." Not only is science biological and social: it is artistic and vocational, i.e. is of the spirit.

It is not only those of us who happen to be scientists who are affected by the spread of science. Many of you will know Lecky's words: "It is impossible to lay down a railway without creating an intellectual influence. It is probable that Watt and Stephenson will eventually modify the opinions of mankind as profoundly as Luther and Voltaire." Today we should want to put other names into that sentence, but its truth is still as cogent. There is no better way of describing it than in some words of Mr. Bernard Barber in his recent book on science and the social order: "Science is a moral enterprise."

This does not by any means exhaust the discoveries which scientists have recently been making about themselves. And before I leave this matter there is something more which must be said. When Huxley in 1868 gave a lecture with the title, "A Piece of Chalk," his biographer said that for him and his hearers it became a "window into the infinite." It was as if the concepts and pattern of science were not merely satisfactory ways of relating together the varied experiences associated with a piece of chalk: rather was it true that in some strange way the scientific account went beyond what it was originally designed to do; it became a window. I believe that this is true quite generally of much of our science. And those who look through this window can never be uninfluenced by what has been revealed to them there. It seems as if scientific truth was somehow inseparable from a personal relationship to the universe we study. W. K. Clifford at the end of the last century could assert that truth is "not that which we can ideally contemplate without error, but that which we may act upon without fear." Is there not here some echo of other words, better known?—"Ye shall know the truth, and the truth shall make you free." Science and faith are speaking the same language.

Huxley's lecture could be called a "window into the infinite." Now there are two respects in which the use of this word "infinite" may be justified for

science. First our science gives us that which I can call by no other name than insight; not a collection of facts, but a feeling that in some sense we have come to grips with that which is outside us, and beyond us. So our science is not just a summary of past experience, but an opening of the clouds to show us something we could not otherwise have known.

Linked with this is another respect in which we may rightly use the word infinite about our science. I am thinking of the way in which no limits can be placed upon scientific inquiry. "Scientific thought," said Clifford in an essay with the title "The Unseen Universe" which he contributed to the *Fortnightly Review* of 1872, "does not mean thought about scientific subjects with long names. There are no scientific subjects. The subject of science is the human universe, that is to say, everything that is, or has been, or may be related to man." Science, beginning with the simplest ideas and experiments such as the rolling of balls down inclined planes, or the dissolving of common salt in water, moves forward in a ceaseless, if erratic, progress. It will never reach the infinite, but equally surely there are no limits to its advance. And whoever attempts to restrict science, or to confine it, or to use it for personal interest or private gain, blasphemes against the Holy Spirit.

Now either all these things which I have just been saying are pure nonsense, or they have led us to a quite new situation. If science is biological, social, of the spirit, a moral enterprise, and if it may be called a revelation, and if there are no limits to the objects of its study, then surely *we* can say of it what, in the second stage of our story, hardly anyone would have dared to say: science is itself an essentially religious activity. It is not the whole of religion, but it is a part. It has its models, its concepts, its windows into the infinite: what hinders us from claiming that these are its revelation? But of course this revelation is not complete. As Pascal put it: "The last step that Reason takes is to recognize that there is an infinity of things beyond it." Or, in the words of Erwin Schrödinger: "The scientific world-view contains *of itself* no ethical values, no aesthetical values, not a word about our own ultimate scope or destination . . . its world-picture does not even contain blue, yellow, bitter, sweet, beauty, delight and sorrow." The operative words here are "of itself." For my case is that science of itself is absolutely sterile. Science is part of man's endeavor to know himself in his environment and as it progresses it becomes most intimately related to all other ways of knowing. What links it thus is the concept of a person. If you reject the role of the person, then the models and patterns of science will leave no room for anything else that coheres with them. But if you accept the role of the person, and see reality as most closely bound up with people, science becomes one of the languages in which God is described.

At last we can begin to see those apparent conflicts were growing pains, as science strove to establish its legitimate right. But when we speak of *its own* models, *its own* concepts, *its own* status, we must mean it in a relative and not an absolute sense. Science plays its part in the fulfilling of human life along with many other influences, and cannot be wholly separate from them. The scientist Max Planck could say: "Religion and Natural Science are fighting a joint battle in an incessant, never-relaxing crusade against scepticism and against dogmatism, against disbelief and against superstition, and the rallying-cry in this crusade has always been, and always will be: On to God." And the philosopher Abdu'l-Baha said, "Religion and Science are the two wings upon which man's intelligence can soar into the heights . . . Should a man try to fly with the wing of religion alone he would quickly fall into the quagmire of superstition, whilst on the other hand, with the wing of science alone he would also make no progress, but fall into the despairing slough of materialism."

If our conflicts were growing pains, we ought to be growing out of them. I wish I could feel happy in believing that we see the positive implications of the liaison of which I have been speaking. I said that before I finished I should speak of a sense of urgency that I cannot rid myself of. It is through the efforts of science and scientists that mankind has now acquired almost unlimited power. Do we know how to use it rightly? I am not sure. We have devised not one, but several, ways in which we can destroy one another. Most of us in the scientific movement are deeply troubled. We know the truth of Rabelais' remark: "Science sans conscience n'est que ruine de l'ame." But many of us don't know what to do about it. I believe that our trouble is that we have forgotten some of those other elements of truth to which we are joined. The clue to our hesitation will be found in what is, for many of us, an inadequate concept of what is a human being. Here science can help enormously, but it is not enough by itself. We must be willing to open our hearts and minds to the revelation of truth of whatever school or subject. When I think of the awful responsibility of decision in such matters as the hydrogen bomb, then I am tempted to argue that unless we can bring together science and conscience, power and purpose, freedom and responsibility, civilization itself has only a bare chance of survival.

Not until the power conferred by our knowledge has been recognized as God's gift; not until man's new independence is seen to be but the liberty of the children of God; not until man's patient observation of the world around has led him on to awe and then to worship; not until our science has shown us with what rich lustre the heavens declare the glory of God, and the firmament shows His handiwork; not until then can human faith be as it was meant to be, nor human life fulfill its proper destiny; and our hearts be so astonished at the splendor of God's creation that they grasp eternity in a moment of time, and are lost in wonder, love and praise.

KNOWLEDGE, FAITH AND PHYSICS*

Henry Margenau

Yale University

The Importance of Scientific Coherence in Religion

A pulpit holds terror for me. The last time I mounted one to address a similar audience my apprehensions reached that point of mental confusion at which I scattered my notes onto the floor of the church, and I recall with horror the painful scene in which the kindly dean of the Divinity School picked up my papers while I stood impotently watching from on high.

You will forgive me, I trust, if I insert a personal word. My business is science; more exactly, it is that renowned and much maligned science called atomic physics. To be honest I should say, however, that some of my colleagues regard me as anomalous, if not subversive, for I have occasionally left the fold and speculated about philosophy. With this preamble you will understand the general direction and the limitations of my views, and you will see that I am practically forced to concern myself with one and only one theme: *The Relation of Science to Religion.* I need not point out—for it will be abundantly evident—that my competence in theological matters is that of a layman; yet the questions I hope to raise are rooted in deep concern and in a desire for clarity on my own part which are difficult to suppress.

Religion and science are said to be in conflict. The curious fact about this conflict is that it seems to be perennial. Nor is the antagonism entirely academic. It has sweeping consequences in human action, in the moral field, consequences which cannot be ignored. For religion in our Western sphere has two aspects, one cosmological and one moral. Cosmological religion with its profuse speculations about the universe covers in part the field of natural science. In its moral phase religion develops a code of human behavior and tries to commit men to it by an appeal to faith. Now, if science can show that the cosmological claims of religion are wrong, religion's case in the moral field is greatly weakened. This is precisely what has happened in our time. Men believe that science has overpowered religion in the natural realm, and they look to *science* for guidance in the sphere of human action and in the spiritual sphere. If perchance they were wrong, our time might easily be the eve of doom.

I do not believe that the contest between religion and science has been decided in the cosmological field; nor that it ever will be decided. This belief is based, first of all, upon a simple fact of history. Science is not an unchanging, static set of propositions, not a permanent body of approved facts. Quite obviously it changes, and the changes are not merely additions of knowledge. Revision of basic tenets, overthrow of assumptions that proved erroneous are the marching orders of science, and the vital dynamism of this human enterprise is a result of this liberality of its method. Religion, too, is in a state of progress in spite of the reactionary insistence on codified eternal truth by fundamentalists who refuse to enlarge their horizons. The evident fact is that both science and religion are involved in a process of growth, and if one were pitted against the other and were said to be the winner, who could guarantee the finality of that victory?

There is in fact a need for continual reappraisal of the relation between religion and science, and never was this need greater than it is today, for science has recently undergone a revolution of its fundamental concepts that is unique in history (and I am not speaking of such scientifically trivial things as atomic and hydrogen bombs). The complete refutation of old-style materialism in modern physics is sweeping in its philosophic consequences and many things that used to be said about the conflict in question are simply no longer true.

These are generalities; let us now face specific aspects of our theme. To me it has always been a curious and yet significant fact that at the very beginning of the document which many of us regard as divinely inspired, religion is said to grant a charter to science, with an implication that the two shall live in peace. First, you recall, there was chaos, terminated by a divine act of creation. Then followed a period of lawlessness and confusion that ended in the great flood. One interpretation of the turbulent days prior to Noah's Ark, which is elaborated in the Jewish Talmud, emphasizes that during this period nature, and

* A layman's Sunday sermon, delivered in the Center Church, New Haven, Conn., October 17, 1954.

nature's God, did not act in accordance with consistent principles; that there were no natural laws and, hence, no possibility for natural science. Lawfulness, behavior in conformity with reasonable principles, was God's gift to Noah, made in the beautiful covenant of the rainbow.

Jehovah smelled the sweet savor; and Jehovah said in his heart, "I will not again curse the ground any more for man's sake, for that the imagination of man's heart is evil from his youth; neither will I again smite any more everything living, as I have done. While the earth remaineth, seed-time and harvest, and cold and heat, and summer and winter, and day and night shall not cease." And God said, "this is the token of the covenant which I make between me and you, for perpetual generations, I do set my bow in the cloud, and it shall be for a token of a covenant between me and the earth. And it shall come to pass, when I bring a cloud over the earth, that the bow shall be seen in the cloud, and I will remember my covenant, which is between me and you and every living creature of all flesh."

If I understand this passage correctly it means to say that the order of the universe is a divine gift. Religion here acknowledges the legitimacy of science. It remains for science to make an equally generous reciprocal gesture to religion.

The symbolism of this covenant has remained alive as a vague religious motive in the work of most scientists. The very word "cosmos," meaning ornament or beauty, along with the Greek myth of the harmony of the spheres, discloses a remnant of elemental religion. Expressions of reverent amazement at the regularity of physical nature, at the simplicity of natural laws, at the sweep of the human intellect in its control of nature have sounded through the ages as religious overtones of science. It is heard in the utterances of modern scientists as clearly as it speaks from the eloquent writings of the theologian, Schleiermacher, who paid tribute to the one miracle before which all others lose their meaning, that miracle being the absence of breaches in the lawfulness of nature, the absence of miracles in the pedantic sense. But the lawfulness of nature, while big with religious implications, is hardly a sufficient basis for claiming general compatibility between religion and science.

Let me show you some other areas of contact. To see them clearly, we must first remove a few very common prejudices that falsify the meaning of science, errors which have been popularized and are especially harmful today.

It is widely believed that science deals exclusively with *facts* and since facts stand supposedly in contrast with *values,* the latter are wholly immune to scientific treatment. Let me say with all the emphasis at my command that science is no more interested in bare facts than any other discipline. It is interested in *relevant* facts, that is to say, in facts with meaning through their relation to concepts and laws. A social psychologist who reports, no matter how accurately, objectively or tediously the facts in a certain area of human conduct does not thereby become a scientist; not even if the facts are novel, surprising or shocking. To command attention beyond publicity he must show how these facts are connected with basic issues that transcend the domain of these particular facts. It is not enough for the scientist to know. What he wants is *understanding,* and understanding requires both *facts* and *ideas,* observation and conjecture.

The preoccupation with facts which is so characteristic of our age is anchored in a philosophic aberration that is slow to disappear. In one form it is called positivistic empiricism and represents the view that reality is confined largely to sensory data, to immediacies which present themselves with indubitable force through our senses. The exponents of this view fail to see how barren, indeed, how impossible their own lives would be if they embraced their own dogma with conviction. They are furthermore blind to the state of affairs in modern science, particularly atomic physics where exclusive emphasis on immediate sensory experience would be ineffective and ridiculous.

Another philosophic fashion of the day is the tendency to mystic withdrawal into the realm of contingencies, so characteristic of existentialism. Contingencies are the brute facts of existence prior to illumination by understanding. Disappointed men, men unwilling to exert themselves through the power of reason, take refuge in the resigned belief that existence is beyond human control, that it is human fate to be submissive to the facts one meets. Such doctrines are widespread on the continent of Europe and in South America. They may take religious forms as in the writings of Gabriel Marcel, or they may result in neurotic literary exhibitions of the nausea of existence as in Sartre's work. Most of them arise from the misapprehension that brute fact alone is meaningful, that is, from the same error which falsifies the popular appraisal of science.

What science actually achieves is a correlation of facts with ideas. It needs facts as our body needs food, but within the organism of science, facts are processed, combined, organized and connected by a texture of reason, and it is the whole of the organism, including that texture of reason, of ideas and conjectures, which is science. In a very deep sense, science has its origin in the circumstance that in the deliverance of our senses, the facts are not sufficiently orderly to satisfy our desire for simplicity and consistency. Science is an elaborate answer to the paradox of the bruteness of our experience. To summarize: incoherent facts are unified by science into a consistent whole with the use of reason.

To achieve this goal, science transcends the facts. It employs what is known as the deductive method which goes from assumption or premise to conclusion. The premises of science are called postulates, and they cannot be demonstrated to be true by facts. Let me illustrate. When I explain the observation of

a falling object by saying that the earth attracts it, I am making an abstract statement which cannot be directly verified. Nobody has seen this force of physical attraction, and no one ever will. What the statement means is this. If I assume, following Newton, an inverse square law of force, then the consequences of this assumption agree with the facts observed. The same facts may possibly also be consequences of some other assumption or theory not yet considered, and so it is with most fundamental theses of science, with all great generalizations. They are never proved directly. Their ultimate validity is never assured. Being postulates, which can only be verified through their consequences, and having, therefore, only the tentative validity of assumptions, their acceptance requires more than correct knowledge of facts. It requires a *commitment,* an espousal of unproved postulates often called axioms which, logically speaking, is of precisely the same nature as what we call *faith* in religion.

From this analysis flows an important result. The judgment of science is never final, never ultimate. Science recognizes eternal *problems,* but no eternal *truths.* It learns, it progresses; yet its job is never done. In the writings of the poet, Lessing, one finds a memorable allegory. Man confronts the deity seeking wisdom. God, willing to grant it, gives man a choice. In his left hand, as I remember the story, he holds the virtue called eternal search for truth; in his right, absolute and final truth. After some reflection man makes this humble plea: "Lord, open your left hand for me; grant me the virtue that I shall forever strive for truth, whose ultimate possession would produce a stagnancy I cannot endure." That was the scientist speaking.

You may find a more pleasing version of the same thought in Hodgson's "Mystery" which runs:

> "He came and took me by the hand
> Up to a red, rose tree,
> He kept his meaning to himself
> But gave a rose to me.
> I did not pray him to lay bare
> The mystery to me,
> Enough the rose was Heaven to smell
> And his own face to see."

Science has its share of dogmatism. There are those who regard the present stage of scientific knowledge as ultimate and refuse to consider phenomena or experiences outside its momentary competence. They make a distinction between what science is now able to explain and what escapes its grasp; the former they call natural, the latter supernatural, and they believe this partition to remain meaningful. According to this unreasonable notion, radio and television were supernatural phenomena until the twentieth century, during which they were demoted, or, if you please, regularized to the status of natural. Yes, dogmatism in science arises from the mistaken belief that its present principles of explanation are forever valid and forever sufficient to embrace all experience.

And dogmatism in religion, equally indefensible and equally mistaken, rears itself upon the arrogant conviction that religious truth is laid down once and for all in a static pattern, rigid, lifeless and inexorable, incapable of progress and improvement. These bone-dry dogmatisms always clash and clatter, and the noise they make through the centuries is taken as the sign of conflict between science and religion.

If there is no conflict, can religion join its facts and its ideas through rational bonds in the same way science does? To answer this, let us first make sure we know facts of religion. For my part, I see them residing in those experiences most men acknowledge to be peculiarly religious, in the spontaneous feeling of gratitude that wells up in man's heart on a joyous day, the feeling of awe in the face of overwhelming beauty, the guiltful contrition that follows a sinful experience, the sentiments of misery and abandon at the insufficiency of human power before fate, the longing for grace and redemption. Just like the facts of science, they are unconnected, disorderly and insufficient in themselves, requiring a texture of rational organization. And this, I take it, is what formalized religion or theology aims to provide—that its theory is replete with intangible ideas, that in the terminology of its detractors it bristles with the "technicalities of salvation" is small wonder to one who is familiar with the intangibles of science. Their presence in itself is no objection. The success of religion is measured by the degree of rational coherence which it bestows upon these singular religious experiences that assail the sensitive mortal.

In the beginning of my talk I alluded to Jehovah's covenant as establishing a charter for science. "While the earth remaineth, seed time and harvest; and cold and heat, and summer and winter, and day and night shall not cease."

Is there no religious analog to this pledge insuring the lawfulness of nature? That pledge converted an intolerably lawless state of affairs into one affording reliability and comfort. If you analyze the oppressive, brute facts of religion, the experiences I have mentioned, you find them reflecting, I think, very largely the message Genesis 3 speaks to Adam, "cursed is the ground for thy sake; in toil shalt thou eat of it all the days of thy life; thorns also and thistles shall it bring forth to thee; and thou shalt eat the herb of the field, in the sweat of thy face shalt thou eat bread, till thou return unto the ground."

Now pass from there to the words of Jesus in Matthew 11: "Come to me all ye that labor and are heavy laden, and I will give you peace." Here is a religious theme of supreme satisfaction, an organizing idea of power and simplicity in terms of which many crude experiences make beautiful sense.

To bridge the gap between Genesis 3 and Matthew 11 by a texture of rational connections is one of the important tasks of professional religion. And the true scientist will applaud its successes.

THE HARMONIC DIMENSIONS OF NATURE

Donald Hatch Andrews

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New Science Approaches New Faith in Perception of the Integral Order of Nature

You and I, living in these middle years of the twentieth century, are members of a unique generation of mankind. Through the discoveries of science, there has been placed in our hands the key to the energy of the atomic nucleus, the *basic power of the universe*. For good or for ill, we have at last brought the eternal fire of the stars down to earth. And all too clearly we discern in this event the elements of Promethean tragedy. Now, for the first time in the history of this planet, there can rise at our command power gigantic enough to change the entire face of the globe. It is power which, if controlled, can be used to create a new world order, eliminating all poverty and want, providing a world of peace and plenty for everyone everywhere. But it is power which, if uncontrolled, can result in a world utterly destroyed. We, the men and women of this middle decade of the twentieth century, must make the choice between these alternatives. Both our future and the future of generations of mankind for countless millennia rest on our decision.

This problem of the control of power is not a new one. Especially during the last five hundred years the human race has tried to arrange its material power in a pattern to ensure a stable economic and social order. There has been a constant search for balance of power, the strength of one nation, or group of nations, balanced against that of another. But even at the low power levels of the last few centuries this formula has not worked too well, and as the amount of material power in the world has increased, the balance has become less and less stable, as is shown by the record of the last fifty years with two global wars.

Today, with nuclear power added to all the rest, it is clear that the level has been passed beyond which we can ever hope to control material power by material power. From now on material power must be controlled by something higher than itself. Our one hope lies in the control of the world's *material power* by an increased power of the *human spirit*.

This may seem like a pessimistic answer. What right have we to expect that our generation can achieve any greater moral stature than our forefathers in dealing with world security? Our record so far is not too good. Yet there is a new element of hope with us today, because this same science which has given us *atomic power* has also given us *atomic vision*. Through the microscope, the spectroscope, and the telescope we are getting an entirely new view of the *basic realities* of which both the universe and *we ourselves are made*. And we are making the startling discovery that, in a word, the basic reality of our universe is not matter but music. We find that the materialistic philosophy of nineteenth century science is no longer tenable. We are not yet quite sure what the new philosophy of twentieth-century science is, but we see that the most fundamental concepts appear to be based on relationships of harmony and resonance rather than on mass and mechanics. And from this new basis we see emerging an entirely new philosophy, a revolutionary set of concepts which put science into a new and more harmonious relationship with religion, a pattern which adds new vigor to old faith. It strengthens our hope that we *can* find spiritual power to meet the problems of this atomic age.

As a start in understanding this atomic vision of our universe, it is well to get an idea of the magnitude of the power we are releasing through atomic processes. You know that you could hold right in your hand the little chunk of uranium derivative metal which was the war-head of the bomb which dropped on Hiroshima. In that small piece of metal there was packed the explosive power of twenty thousand tons of T.N.T. It represented a concentration of power far greater than any ever known heretofore.

Yet you also know that the Hiroshima bomb was small and inefficient compared with the bombs with which we may have to deal in the near future. Uranium is scarce and has properties which appear to put an upper limit on the size of bombs which can be made from it. There are many other substances, how-

ever, from which bombs can be made. Of these, the most promising is hydrogen. It is abundant, as uranium is rare. It offers the possibilities of bombs of at least a thousand times greater power than the original uranium bombs, with no evident upper limit on the size. There are difficulties in the way, such as the necessity for using special kinds of hydrogen, the heavy isotopes, but, evaluating the rate of progress of scientific research, the general opinion is that hydrogen bombs are one of the most significant factors in the present and future problems of our world.

To give a brief idea of the possibilities, let us suppose the secret of releasing the atomic power of ordinary hydrogen to be known and that, by a special spark, you could instantly fuse all the hydrogen in your body. In such a process you would explode with force some hundred times greater than the bomb which dropped on Hiroshima. I hope you never want to try this experiment. But remember that there is hydrogen not only in all our bodies but in all water, H_2O, in lakes and oceans, so there is the possibility of the construction and detonation of an unlimited number of hydrogen bombs; and there seems to be general agreement that widespread hydrogen bombing will produce an increase in the radioactivity in the earth's atmosphere which will threaten the existence of life on the entire planet.

Realizing this threat, many people feel that an effort should be made to stop all atomic research at once. It is too dangerous, they say, and our society is not ready for it. They think that we should have an international agreement to close all the laboratories and lock up all the uranium. Others hint that such a course would be ineffective, that scientists are so curious that, even though laboratories are locked, they will continue to experiment down cellar or up attic. Thus they conclude that the only answer is to shoot all the scientists. I am not personally in favor of that solution, but if destructive power were the only use for atomic energy some such drastic action might be required.

We must not forget, however, the positive side of the picture, the good which can be done if atomic power can be controlled for constructive purposes. Again, as a brief example, if you only knew the secret of converting the energy of the hydrogen nuclei in your body into controlled electrical energy, you could rent yourself out as a power plant for the public utilities companies, and with just the energy of the hydrogen in your body you could operate all the factories and light all the lights of the entire United States for many weeks. It is a stimulating thought, when one is tired, to contemplate all the energy one's body really contains.

Now, how soon atomic power will be available on a large scale for industrial purposes we cannot say. Some prophets of science are more optimistic than others. In England the prediction has been made in terms of ten to twenty years. Much depends on the international situation and the diversion of our resources toward military ends. However, it is worthwhile to stop and think what this power can mean in shaping a better world for us to live in, if we can only maintain a stable civilization in which science and technology can function creatively.

It is estimated that in the year 1800 there was only about a hundred thousand horsepower available in the entire world for supplementing human muscle in doing work. Today, with steam, electricity, and internal combustion combined, we have well over a billion horsepower. This ratio of increase is so great that, if our working day had been shortened in the same proportion, we would each be working only about five seconds per day. Most of us work a good deal more than that, and one of the reasons for it is that so much of our power has gone not for building a better world, but for destroying it.

Now if the billion horsepower available from steam, electricity, and petroleum has been able to revolutionize our economy so effectively, even while used inefficiently, think what another billion or even ten billion additional horsepower from atomic energy may do. It is clear that we can, if we will, reduce the cost of power so that it is practically as free as air. There is no reason why in another fifty years all of us should not be lighting and heating our houses for a total cost of less than one cent per month. We know that the power is all around us, literally oceans of power only waiting to be put to work. We can, if we will, eliminate all want and poverty everywhere, have everyone in the world well-housed, well-clothed, well-fed, well-educated; we can at long last achieve the good life for all mankind.

Is not that a goal to be sought at almost any price? Economically, the cost is low, relatively almost nothing. But the price must be paid not in dollars, but in discipline. Somehow we of the human race must learn to *control ourselves before we can control our power*. The crucial question is: *Will our new science help us to achieve a new wisdom of the spirit, a new sense of destiny?*

In order to illustrate some of the points of view of our new science, let me take you on a short trip inside an atom, say an atom of calcium from the bone in your finger. This atom is, of course, very small. There are more atoms in your hand than there are grains of sand on all the beaches of the entire world. In order to make this atom of calcium big enough to look at, suppose you eat an Alice-in-Wonderland growing pill. This makes you shoot up above the roof, through the clouds, through the stratosphere, past the moon, past the sun and some of the planets, until you are enlarged by a factor of a trillion. If you don't know how big a trillion is, it's about what the national debt will be in a few years.

Enlarged by this factor of a trillion, your atom of calcium grows into a great ball about a hundred yards across so you (in your normal size) can step

in and have a look around. You will see first of all, moving in great circles up over your head, down at the sides, and under your feet, some twenty luminous spheres about the size of footballs, swinging around you like planets around the sun. These are the electrons, the particles of negative electricity which make up the outer part of the atom. Some of them occasionally swing out and circle around neighboring atoms like dancers in a square dance, and this motion provides the forces which tie the atoms together into a chemical structure. If you try to find what the "sun" is, about which these planetary electrons are circulating, you have to look at the center of this calcium atom, and there you see a tiny whirling point of light, smaller than the head of a pin. That is the atomic nucleus which contains practically all the mass of the atom, as well as its atomic energy. Even with the atom enlarged to a diameter of a hundred yards, the nucleus is still smaller than the head of a pin, so you see how small it really is. This is what physics calls the "particle" picture of the atom.

If you ask what else there is in the atom, the answer is nothing. From the "particle" point of view, there are just a few electronic footballs and the nucleus, and that is all. Since you, yourself, are made of atoms, you, too, are nothing much but empty space. If I could put your body in an imaginary atomic press and squeeze these atomic holes out of it, just as the holes are squeezed out of a sponge, you would get smaller and smaller until finally, when the last hole was gone, your body would be smaller than the smallest speck of dust which you could see lying on a piece of paper. That is how little you amount to in a material sort of way.

Thus, the first lesson we get from our new science is that *seeing is not believing*. Your hands look solid and feel solid, but they are actually more full of holes than a wire fence. And, of course, we are all familiar with the fact that with X-rays you can actually see right through your hand. If, then, your hand in the older material sense is so tenuous and empty, why does it look and feel solid? If materially you don't amount to much, what are you?

DURING the last twenty years, studies with the spectroscope and particularly with diffraction apparatus have given a startling answer to this question. To illustrate this, suppose we return inside your calcium atom but this time have new "glasses" and a "hearing aid" which enable us to "see" and "hear" in the new wave spaces which encompass the whirling planetary electrons and the nuclear sun. As we look and listen, we "see" first of all ripples and waves moving around with the electrons, like the ripples and waves on a pond when a stone is dropped in it. We hear a humming like a hive of bees, and if we turn up our hearing aid we become aware of overwhelming music all around us, although hitherto we had been completely unaware of it. We realize that we are listening to a vast symphony. The range of tones extends many octaves beyond anything we have ever heard in a concert hall. We detect chords which are sometimes familiar, but yet part of a vaster pattern, complex, rich in texture beyond any music ever dreamed of in a human brain. As this music surges around us, we come to realize that it is here in these patterns of harmony, melody, and counterpoint that we have the true reality, the essence of what it is that creates what we see, what we feel, and what we are. This is the "wave" picture of the atom which now complements the older "particle" picture. Thus by the magic eyes and ears of science, we behold the vision of this hitherto unseen and unheard realm in which we all constantly *live and move and have our being*. We can now at last "tune in" to the music of the spheres.

Our new science thus teaches us both that *seeing is not believing* and that *we must believe in much that we do not see*. What these mysterious waves of harmony are, it is still too early to say, if indeed the question is itself meaningful. But we can say that the basic concepts, by means of which we have to interpret ourselves and our universe, must now be recognized as necessarily of a very new kind. In brief, they pertain more to music than to matter. And we soon recognize that the basic philosophy or structure of a universe of music is very different from that of the materialistic nineteenth century "universe" constructed on the pattern of classical mechanics.

First of all, we see that the essence of reality or significance in musical pattern is the quality of invariance under transformation. We know that a chord or melody can be transposed, metamorphosing, through many keys and timbres, while still retaining its identity. We have to recognize that in the interpretation of all physical phenomena this property of invariance is specially significant, particularly so in the phenomena of life.

In a simple life-cycle like that of a seed, we see how a relatively small collection of atoms somehow possesses in its corporate structure a power to go through metamorphosis and retain invariance and reproduction. When the seed is planted, there is somehow power in that music of life within it which can reach out and compel the surrounding oxygen and nitrogen and moisture to do its bidding. We have the roots going down, the shoots springing up, until, through growth unimaginably complex, there emerges the great tree and the seed reproduced thousands of times, in which our original pattern re-emerges essentially unchanged. The atoms change, but life is unchanged.

THUS, both in music and in life, it is the whole rather than the parts which has the greatest significance. If you take a single note from a symphony, it may be pleasing or it may be harsh, but it has little meaning by itself. It is only in the whole structure of the symphony with its melody, harmony, counterpoint, symphonic pattern that we get the real symphony. And we recognize the reality as being

something that *transcends* the black marks, notes on paper, or the beating of air on the ear drums, or wavy grooves on recording discs. None of these latter *is* the symphony; they are only representations of a deeper reality of the whole. It is this pattern of the whole which, in a radio broadcast, can be transformed from sound waves to electrical waves, to radio waves, back again to electrical and sound waves in the receiver, and finally to the mysterious brain waves by means of which we at last perceive it. Throughout this series of transformations, the pattern of the symphony is essentially invariant. It is the pattern of the whole and nothing else which can properly be called the real symphony. In the same way, the mysterious music of life in a seed or in a human being *transcends the vehicle* of its functioning. Thus we recognize, according to this logic, that in the innermost essence of life we have the implications of the supreme reality—call it ego, soul, spirit, or what you will. It is to this conclusion that we are led by the pattern of thought with which our new science presents us.

There is admittedly difficulty in the acceptance of reality as residing anywhere but in tangible matter and energy in familiar time and space, especially for those of us who have been reared in the tradition of nineteenth century physics. We have thought of tangible matter as permanent, subject to the classical conservation principle. A pattern of waves or of music may last for a while, it may retain an invariant form through many transformations, but doesn't it have to last *forever* to be called *real* in the sense that we call matter *real?*

BEFORE even trying to answer that question, we have to reflect that our new cosmology with its new light on the nature of the beginning of things is changing considerably our views on the boundaries of time and the meaning of *forever*. We are not sure that even matter either has been or will be here *forever*. We have to remember also that these new "waves" are not present in the ordinary sense in our familiar three-dimensional space, but are more properly a representation of something which is on the one hand a significant reality in that it influences observable phenomena, but on the other hand is most significantly represented in space or spaces quite different from our familiar three-dimensional space. Also, we do not know the relation of these waves to the boundaries of time. We cannot grasp with finite minds the meaning of even making assertions about these boundaries, *aeternitas ante* or *post*. But it does seem fair to say that when the larger patterns of these waves, as in life phenomena, both exert power and show invariance under transformation, we feel that here is something closely akin to a new and highly significant reality.

When we speak, as in the preceding sentence, of "larger" patterns, it is well also to pause and reflect a moment on the scale factors involved. Suppose, for example, that we are considering the phenomenon of human life. How vast is the integral pattern of the waves or music which is this human life pattern? In the average human body, there are roughly an octillion atoms, 10 raised to the 27th power (10^{27}), a number almost inconceivably vast. An octillion birdshot would far more than fill the volume of our whole planet. Now each of these atoms is a little planetary system of its own, with its "sun" nucleus and associated planetary electrons. Each has its accompanying waves, its own chords which are fused into the inconceivably vast pattern of the octillion whole, a kind of "island universe" of atomic suns and planets. To think that such complexity could be ordered to produce coherent conscious human life, this is indeed an almost unbelievable miracle. And yet there is somehow within this island universe, somehow within its vast symphony, an integral quality which results in a human existence which *is* both coherent and conscious.

Now still another branch of modern science, astrophysics, permits us today to compare the island atomic universe within us to the stellar universe without. As in the atom, we find that in our cosmos the concepts of time and space must be changed from those of a century ago. We believe that our cosmic universe is not infinite, but that it actually has something like a diameter, the diameter of space curving back upon itself. You ask what is beyond, and I have to say, if anything, the unimaginable *nth* dimension.

Now here is a striking fact. It appears that the size of the human body is very roughly about as great compared to the smallest particle contained within it, as the size of the entire universe is to the human body. Thus, in ratio, the human body stands about midway between the very smallest significant size recognized by science and the very largest.

In terms of numbers, the human body contains roughly 10^{27} atoms, and there is some evidence that the entire universe contains about $10^{27\times3}$ elementary particles, a power of ten only about three times that for the body. Thus, although the human body may seem infinitesimal compared with internebular spaces, the difference in scale is perhaps not so overwhelming when viewed in *ratio* of size or *complexity* referred to the elementary particles. And this may be a much more significant measure.

SO let us turn to one final implication. In your 10^{27} (octillion) atoms in your private "island universe," there is the coherent and conscious *integral symphony of the spirit;* it is an amazing miracle, but you know that it happens, you know that you live. Is it, then, a greater miracle that there should be—permeating the universe without, resounding in its $10^{27\times3}$ particles—the spirit of its Creator? As the life of the body extends throughout every part, an all-prevading symphony, why should we wonder that in the music of all the spheres there is a pattern equally coherent, equally personal?

Thus, through this new vision of science, we move closer to that faith which asserts that there is a Creator of the universe who holds in his hands the farthest reaches of the stars and yet stands close to each of us, an ever-present, ever-loving Father ready to strengthen and sustain us if we will but turn to him.

Accepting this new vision of reality, we see that we live and move throughout our lives in an unseen world of the spirit, the realm of the music of the spirit, the spaces of the music of the spheres which, though unheard, is closer to us than the air we breathe, the dimensions of transcendent reality.

All of us who aspire to be responsible members of the human race will have to bear the burden of the great gift of material power which science has given to mankind through atomic fission and fusion. If we can keep, throughout our lives, a vivid sense of this *reality of the spirit,* of the *presence of our Creator,* the vision of the invisible kingdom, the eternal verity to which science itself gives affirmation, then we can go forward confidently into this new atomic age on the road to a high destiny. And in the day when mankind shall finally establish peace and good will on earth, we may see at last the deepest meaning in the words, "Ye shall know the truth and the truth shall make you free."

The Editors of MAIN CURRENTS feel impelled to add their voice to those countless others which have spoken in honor of the scientist and philosopher, Albert Einstein. Even by the midpoint of his lifetime, he had shone a clear light upon the material vesture that clothes reality. By the end, it was no less clear that he had brought warmth and courage to the dark social scene of our times. His departure takes away the living presence. It is for us to prize and use the pure and steady light of new truth which was his gift to us.

We feel that a discussion of the juncture between science and religion would be incomplete without a few representative words from this man who, more than any other living today, exemplified his adherence to the highest principles of both. As Henry Margenau said in the *New York Times* of Tuesday, April 19, 1955: "More than any modern thinker, Einstein is imbued with a conviction of the fundamental orderliness and beauty of the cosmos, a conviction that leads him to demand a high measure of elegance and simplicity in his own conjectures and makes his scientific creations partake of the elements of the highest art. This basic attitude, which sees in the workings of nature not merely secrets to be discovered but pattern and design to be explored, is obviously the living stratum which contains the wellsprings of his manifold successes."

The following is taken from *Ideas and Opinions,* by Albert Einstein, Crown Publishers, N. Y., 1954, pp. 45-49, and comprises a section of a Symposium, *Science, Philosophy and Religion,* published by the Conference on Science, Philosophy and Religion in Their Relation to the Democratic Way of Life, Inc., New York, 1941:

"Even though the realms of religion and science in themselves are clearly marked off from each other, nevertheless there exist between the two strong reciprocal relationships and dependencies. Though religion may be that which determines the goal, it has, nevertheless, learned from science, in the broadest sense, what means will contribute to the attainment of the goals it has set up. But science can only be created by those who are thoroughly imbued with the aspiration toward truth and understanding. This source of feeling, however, springs from the sphere of religion. To this there also belongs the faith in the possibility that the regulations valid for the world of existence are rational . . . I cannot conceive of a genuine scientist without that profound faith. The situation may be expressed by an image: science without religion is lame, religion without science is blind. . .

"If it is one of the goals of religion to liberate mankind as far as possible from the bondage of egocentric cravings, desires and fears, scientific reasoning can aid religion in yet another sense. Although it is true that it is the goal of science to discover rules which permit the association and foretelling of facts, this is not its only aim. It also seeks to reduce the connections discovered to the smallest possible number of mutually independent conceptual elements. It is in this striving after the rational unification of the manifold that it encounters its greatest successes, even though it is precisely this attempt which causes it to run the greatest risk of falling a prey to illusions. But whoever has undergone the intense experience of successful advances made in this domain is moved by profound reverence for the rationality made manifest in existence. By way of the understanding he achieves a far-reaching emanicipation from the shackles of personal hopes and desires, and thereby attains that humble attitude toward the grandeur of reason incarnate in existence, and which, in its profoundest depths, is inaccessible to man. This attitude, however, appears to me to be religious, in the highest sense of the word. And so it seems to me that science not only purifies the religious impulse of the dross of its anthropomorphism but also contributes to a religious spiritualization of our understanding of life."

DYNAMIC STRUCTURE IN HUMAN BEHAVIOR

Ralph F. Hefferline

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A Discussion Based Chiefly on a Book by Floyd H. Allport

As a science matures, its theories reduce in number but broaden in scope. Small areas of research which at first generate their own *ad hoc* explanatory concepts come later to be recognized as special cases, variations, or different levels of organization of a general class of phenomena capable of being systematically related and adequately accounted for by a more economical set of ordering principles. This integrating tendency, as it progresses not only within a given science but also among its bordering disciplines, gives substance to the hope of an eventually unified science and a richer understanding of ourselves and the world.

Psychology, on its scientific side, still embraces a diversity of viewpoints, methods and terminologies. The lay person—and the professional as well—feels somewhat intimidated when he attempts to grasp its basic pattern and to discern its general line of development. Work toward further integration is under way, of course, but thus far the would-be integrators have, for the most part, simply tried to extend the boundaries of their own specialty.

It is welcome news that a man who was eminent in scientific psychology a generation ago but not an active contributor since then has been in the interim incubating a general theory which, if it can be fully developed, will supply a base that is ample for psychology and the social sciences. He is Floyd H. Allport, of Syracuse University. His *Theories of Perception and the Concept of Structure* is a "first installment," to be followed by a work in which he plans to generalize his theory to learning, personality, society ("collective structure") — and perhaps to the universe itself.

He started from the basic postulate that there is in human behavior "some kind of orderly and dynamic pattern." This, of course, has been a common assumption, but many attempts to find and demonstrate it have foundered, he feels, because "the approach was not made wholeheartedly, with a willingness to break from tradition and to envisage . . . pattern as a law or paradigm in its own right." What was needed, it seemed to him, was "an overall, explicit concept of *structure*."

The concept of structure at which he has arrived is so mobile and flexible as to include within itself what customarily has been broken in two—namely, structure and function. Structure, for Allport, is dynamic, not static, and requires no outside agency to set it going. He postulates a prevailing unity in nature and suggests that there may be "some one basic structural paradigm that is universal, that characterizes and unites the orders from the meson, proton, or electron up to organized society." At no point does he believe it necessary to evoke a doctrine of "emergence" to confer "vital" structure by some mysterious process. "Structure should probably be presumed to be pervasive and to be lawfully connected everywhere if it is to exist at all." This lawfulness may not be fully explicable, however, by quantitative statements, important as these are for science, but may demand prior consideration of "non-quantitative, or structural, law."

Like all scientists, Allport is concerned with the problem of objectivity. The basic criterion of objectivity he takes to be "denotation." This term, as he uses it, means "not merely 'pointing out' or 'demonstrating' an object, but actually, physically *contacting* or *encountering* it." Where the contacting can be only inferential he speaks of "quasi-denotation." According to him, "denotation is the principle that lies behind operationalism, though the operationists themselves have not clearly recognized it."

> " 'Public' operations are not more trustworthy than 'private' because they are *public*. They are *both* trustworthy *and* public because they are denotive."

What he calls the present "methodological crisis" in psychology is the familiar scientific dilemma of phenomenology versus physicalism. Phenomenology deals with the private experience of the observer—i.e., "Why do things appear as they do?" Physicalism bans the subjective approach *in toto* and restricts itself to what can be learned "from the outside" of why the observed individual acts as he does. On strict scientific grounds Allport admits that phenomenological report fails to meet the criterion of objectivity, for it defaults with respect to observer-detachment, encounterability, and public operations. "But still it is part of the total picture. Have we a right to ignore it?" He believes

that by and large phenomenological report is veridical—i.e., agreement can be reached between the observer's description of his private percept and what may be inferred from the physicalistic approach—and a place must be made for phenomenology "not because we feel that the observer who has the experience can describe it accurately, but because no one else can describe it at all."

Allport's book, although simply written, assumes that his reader has some knowledge of the problems and literature of scientific psychology. The bulk of it is devoted to a searching examination of thirteen different theories of perception which now exist, each with its particular group of followers. He finds, as would be expected, much common ground in these theories, and some of them, he feels, take for granted or include implicitly what he has tried to make explicit in his own all-inclusive "theory of event-structure."

Allport's theory, although not intrinsically difficult, defies compression into a résumé, and in what follows an attempt will be made only to suggest its overall trend and implications. What is most extraordinary about his work is the steady, step-by-step way in which he spells out the complexity of the universe in terms of hierarchical patternings of the basically simple. The same, elegantly simple, dynamic patterns recur again and again to "structure" ever and ever "higher orders."

It is apparent that Allport has been much influenced by those sciences which deal with "fine structure" — biochemistry, cytology, crystallography, genetics, etc. Stereochemistry concerns itself with the arrangement or patterning of atoms within the molecules, and physics has resorted to the non-quantitative calculus of groups to describe atomic patterns. Readers familiar with discussions of ion exchange, enzyme-systems, polarization cycles, and the like, may decide that what Allport has done is to extend what has hitherto been a way of describing the microscopic straight through to macroscopic phenomena.

Cyclical operation of organismic structures is a key notion for Allport. It ranges all the way from the depolarization-repolarization cycle of a bit of nerve-fiber to the rhythms of appetite and satiation, of repeated effort and fulfillment, or recurrent frustration and eventual completion. A cycle, as he conceives it, is structured of "ongoings" and "events." Any particular ongoing, if examined, is itself revealed to consist of "lower-order" ongoings and events. Events occur at those points in space and time where cycles of ongoing touch or are "tangent to" each other. Events themselves are non-quantitative, but are simply "yes or no" or "all or none." They are "dichotomies" which separate what came before from what came after or, in terms of space, delimit what is here from what is there. Tangent cycles can "contribute" events to each other, or one cycle may "prevent" or "inhibit" events in the other.

Cycles may have similar cycles "in parallel with" them, and the subcycles which make up a larger cycle may repeat themselves at different rates. By deploying these properties of cycles in multitudinous but orderly profusion, and by working up to cycles of cycles of cycles, Allport depicts organic sets, native or acquired acts, personality, society—all these as cyclically operating structures. The question of negative entropy in organisms—i.e., what is the "biasing principle" by which increasing randomness and the trend toward "heat death" is locally reversed?—is lightly, and rather quizzically, touched upon by alluding to relativity theory's dictum that the curvature of space is greatest in regions of "matter" or "greater density of the field."

What has been said above has necessarily been highly abstract and grossly abbreviated. A few further words may suggest how the theory deals with a standard psychological topic—for instance, the matter of "expectancy." Subjectively, this is a readiness to perceive something. Objectively, it is a bodily preparation, a postural orientation or "set." While perhaps visibly immobile, the expectant organism is nonetheless highly active in sustaining the round of neuromuscular sequences which is the organic aspect of the set. When the awaited stimulus (visual or tangible object, auditory tone, etc.) presents itself, the structure of the set is completed and recognition occurs. So long as the stimulus object holds attention—for example, recognition may be followed by examination or manipulation—the structure which is operating includes both the organism and the environmental object.

If expectancy is weak, recognition of the stimulus object occurs only if it is presented under the clearest and least ambiguous circumstances. If, on the other hand, the set to perceive is strong, false recognition takes place, but, since not supported by appropriate further interaction, is then rejected. If overstrong, a set may complete itself in the absence of the environmental object; this, of course, is hallucination.

Sets, when generalized, include not only the readiness to perceive something, but also readiness to perform particular acts (intention), to think particular thoughts, to react according to particular emotional patterns—with corresponding *unreadiness* for action that is unrelated to previous experience. In these terms the role of education might be conceived as being the systematic facilitation and strengthening of sets conducive to personal and social welfare.

This all too summary characterization of Allport's theoretical position may suffice, perhaps, to place it in alignment with the independent efforts of men like von Bertalanffy, L. L. Whyte, and others who are courageously seeking out and establishing a unitary basis of order which may effectively illuminate our present knowledge and most appropriately direct its application.

EXPERIMENTS IN INTEGRATED EDUCATION:

Integrative Forces in Contemporary Medicine

A joint report on integration in modern medicine is published in *Acta Psychotherapeutica,* the International Journal for Psychotherapy, Psychosomatics, Special Education (Vol. II, No. 1, 1954), by Kerr L. White, Assistant Professor of Medicine and Psychiatry, University of North Carolina, John S. L. Browne, Professor of Medicine, McGill University, and Eric D. Wittkower, Associate Professor of Psychiatry, McGill University.

In spite of the immense contributions of modern scientific medicine to human welfare, the authors point out that medicine in both its individual and institutionalized activities is in bad repute with its patients, for the reason that technical advances and preoccupation with facts and mechanisms have dominated the profession, and human, personal values have been relegated to an inferior status. "Medicine's technology has outstripped its psychology and sociology."

The paper is a survey of representative contributions and the relationship of developments which are currently being made to re-evaluate medicine in terms of important formulations about the nature of human growth, development, behavior, and the biological, psychological and social forces which influence adaptive processes. Four major developments contributing to a concept of "comprehensive medicine" are considered: 1. the rapid increase in knowledge about homeostatic and adaptative mechanisms as conceived by Claude Bernard and Cannon and elaborated by Selye and other workers in endocrinology and neurology; 2. the application of Freud's formulation to the understanding of sick persons, suffering from a wide variety of illnesses other than neuroses and psychoses; 3. regard for the growing contributions of the social sciences, particularly cultural anthropology, social psychology, and sociology; and 4. application of epidemiological techniques to the study and prevention of non-infectious diseases.

A logical outcome of the rapid growth in medical knowledge has been not only a fragmentation of diagnostic and therapeutic techniques, but also a profound segmentation of interests and frames of reference. While medical science has advanced dramatically by research into ever narrower areas, it is unavoidable that preoccupation with the part prevents a view of the whole and an understanding of the relations between interacting systems. The authors indicate a countermove to this trend in the development of research aimed at comprehension of biological, psychological, social and cultural aspects of disease, and the transactions between them. Because the high degree of specialization needed in research makes it impossible for one person to acquire competence in a number of related fields, two ways have been adopted in which the exchanges between various systems are studied: first, skills acquired in one discipline are applied to another, and second, skills acquired in different disciplines are applied concurrently to the same problem.

There are five broad areas in which these approaches are used: 1. Psychosomatic studies, in which important new conceptual models have been proposed; 2. Somatopsychic studies, concerned with the effects of disfigurement and physical disablement on behavior and emotions; 3. Psychosocial studies, to correlate psychological illness, disturbed social and interpersonal relations and somatic morbidity; 4. Epidemiological studies, concerned with any reaction, disorder or injury which affects large aggregates of people; 5. Sociological and anthropological studies, which examine the physician's role in relation both to his profession and to medicine as a social institution, since it has been pointed out (by Hall and others) that much of the medical profession's interdepartmental rivalry and its resistance to integrative and holistic viewpoints is associated with its social structure.

RESEARCH of this kind involves cooperation by a variety of medical specialties and social disciplines, with its ultimate objective the development of a communicable body of principles to explain a host of seemingly unrelated facts in different frames of reference.

With regard to education, the authors state "that medical education should be re-examined and restructured in the light of modern developments in medicine, that teaching should be *student*—and not *teacher*-oriented, and that students should be taught to take a comprehensive view of their patients." They find obstacles to this development in the undue concentration in medical schools on matters of interest to "specialized" teachers, emphasis on pathology as *the* fundamental science of medicine, and the construction of the curriculum with allocation of teaching hours "by private treaty between virtually independent departments."

On the positive side, the report mentions a number of curriculum revisions being made by medical schools in a current effort to achieve integrated teaching by crossing departmental barriers: "Medical school deans, psychiatrists, internists, pediatricians and social workers have introduced changes in curricula aimed at developing a comprehensive viewpoint in students and at shifting the emphasis from diseases to patients. One approach is the introduction of first year lectures on psychobiology and psychosocial development, and occasionally, of more formal courses in sociology and cultural anthropology. Another ap-

proach is the second year course at McGill University designed to integrate biochemistry, physiology and anatomy . . . Family care programs such as that at Boston University enable students to serve as family physicians for their final two years . . . At the University of Pennsylvania, selected first year students are appointed 'family advisers' to clinic patients and their families . . . The New York Hospital and Cornell University have inaugurated a 'Clinic for Comprehensive Medical Care' organized about the ambulant patient but extending also into the home and community . . .

"Comprehensive medicine requires integrated teachers. To fill this need Harvard University has established a full-time course as an introduction to graduate study for Ph.D. degrees in basic medical sciences. The common course is taught jointly by members of the different basic science departments of the Medical School. It attempts to extract from the medical sciences 'the common principles and methods that are necessary for understanding the behavior of living organisms.'

"Perhaps the most dramatic development in medical education is occurring at Western Reserve University. The traditional separation between 'pre-clinical' and 'clinical' teaching has yielded to a more realistic division of the four-year course into three phases. The first orients the student to medicine and the patient and presents the fundamental principle of man's structure, function, growth, behavior and relation to his surroundings . . . The second phase deals with disease, first by general principles and then by organ and site. The third phase deals with the care of sick people . . .

"The two principal objectives of all these changes are to teach students a dynamic and holistic approach to human adaptation, and an awareness that emotional and social factors in human health and disease warrant as much attention as the physiopathological."

In conclusion, the authors state that "there are no simple formulae to guide medical research workers, teachers, and practitioners towards any known ideal of education or practice, but that fundamental changes towards greater integration are occurring seems apparent. The creation and moulding of these changes presents both a challenge and an opportunity to all who believe that medicine's first responsibility is to the patient."

SOURCE READINGS: INTEGRATIVE MATERIALS AND METHODS

Religion and Science as Allies

"The Preacher Talks to the Man of Science," by H. Richard Rasmusson, appears in *The Scientific Monthly,* Vol. 79, No. 6, Dec. 1954, pp. 392-394. Dr. Rasmusson has been minister of the University Presbyterian Church, all-student, at Purdue University, Lafayette, Indiana, since 1945 and director of the Westminster Foundation connected with the Church.

Despite customary views to the contrary, religion and science as major aspects of human activity have several vital features in common. For one thing, both are profoundly rooted in "faith" or a "basic acceptance" of certain assumptions which form the whole framework of action but are not absolutely "proven." "Max Planck spoke . . . correctly when he said that over the gates of the temple of science are written these words: 'Ye must have faith.' Faith that our sense perceptions report correctly what is out there. Faith in the trustworthiness of our mental processes. Faith that there is truth. Faith that it is worth pursuing. Faith that it will be worth finding . . . Faith that the universe is orderly and dependable and will be dependable at the moment the scientist performs his experiment in the laboratory. Is all this a small thing to believe? Without faith the scientist at the very beginning of his efforts would be paralyzed.

"The second thing science and religion have in common is that both confront the universe with intelligent minds and seek to make a reasonable interpretation of experience. The scientist follows up sense-impressions and finds that they lead into an external world which becomes the province of his labors. The religionist finds that there are also, in experience, the dimensions of spirit: aspiration, hope, love, dedication, purpose. He finds that these are every bit as real as sense-impressions and that they lead to an order of reality he calls God. The doctrines of religion, like the hypotheses of science, are the outgrowth of a relationship with the universe and the attempt to make meaning out of experience. Science says to man about the physical world: 'Repeat this experiment and you will obtain these results, which mean thus-and-so.' Religion says to man about Christ: 'Make the experiment and you will have the experience.' You will know this religion by what it does in you. It is not blind faith. It is faith as adventure—daring to do the Will."

A third thing common to both fields of activity is that there are those within them who are poor examples of their spirit. "There are scientific fundamentalists just as there are religious fundamentalists. William James once asked why some scientists ' . . . gulped everything materialistic down as peculiarly scientific.' What is the difference between a scientist who dogmatically asserts that the natural order is a closed system and sufficient unto itself, ruling out any transcendent meaning in life, and a re-

ligionist who asserts the verbal inspiration of the Bible and pronounces his anathemas on all who will not with him believe the Bible from 'kiver to kiver?' Bigotry and intolerance can wear the face of either science or religion . . ." Calling attention to the non-scientific dogmas of "scientism," Dr. Rasmusson observes that ". . . scientism imposes a dogma, a frame of reference on reality and says in effect that the laboratory method is the only way of getting at scientific truth and therefore any conviction arrived at otherwise is not truth. The true scientist does not say this . . . Scientists ought never to forget that their very zeal for order and system may cause them all unwittingly to ignore aspects of reality that the net of science cannot catch . . ."

Finally, ". . . science is rooted in a moral order of reality it did not create. Science is possible because there is honor among scientists, refusal to prostitute evidence, courage to report data with integrity. But whence this spirit? Whence this passion, and honor, and devotion? . . . This spirit comes from something greater than science. Science is not its creator, but its debtor . . . Science and religion should not be antagonists. They ought to be allies both in the mastery of life for Christian ends and in the understanding of life. Einstein has said: 'Religion without science is blind. Science without religion is lame.' Paul wrote to the Christians at Thessalonica: 'Test everything; hold fast to what is good.' "

—*F. S. Woidich*

Homeostasis in Psychology

In considering the "Psychological Aspects of the Organism Under Stress," in the January 1954 issue of the *Journal of the American Psycho-Analytical Association,* Dr. Karl Menninger discusses the tendency toward unification of the concepts which have been developed in the various special fields of science, with particular reference to the concept of homeostasis. Although the article appeared over a year ago, it has recently received notice in *Psychological Abstracts,* and it has current interest in view of the recent formation of the Society for the Advancement of General Systems Theory.

Dr. Menninger mentions the efforts of contemporary scientists, such as von Bertalanffy and Schrödinger, to formulate a general system theory which will assist the integration of scientific knowledge and the establishment of new and more comprehensive concepts, and says that these efforts are of particular interest to those working in the fields of psychology and psychoanalysis.

"Von Bertalanffy appears to have made progress, in this direction, by defining organismic theory in such a way as to include both living phenomena and non-living phenomena. Basic in the organismic theory is the universal tendency toward the economy of energy in the maintenance of consistancy and integrity. Cells and cities, people and planets, seem to be governed by a principle of consistency or balance which has been described as homeostasis, the effort to maintain a relatively constant state within defined limits.

"This simple principle of homeostasis is implicit in all organized matter . . . Living structures . . . are actively engaged in the process of maintaining themselves, and use toward this end both internal regulatory devices and external regulatory devices . . . to maintain the homeostatic level consistent with survival.

"Freud used the concept of homeostasis as a basic principle in his metapsychology in *The Interpreter of Dreams* . . . Recently von Bertalanffy, approaching it from a different position, has arrived at a position quite similar to Freud's but with important modifications."

Dr. Menninger discusses von Bertalanffy's use of the term "steady state," rather than homeostasis, in making the distinction between equilibrium in a "closed" energy system and the quasi-stationary state of the "open" energy system, and the implications of this distinction for understanding living organisms. (See also "General System Theory," by Ludwig von Bertalanffy, in the March 1955 issue of MAIN CURRENTS, p. 75 et seq.) When using the term homeostasis, Dr. Menninger writes, he refers to this steady state concept.

With regard to its wider applications, "Homeostasis implies a tendency to achieve an optimal balance between the synthesizing growth process and the disintegrative death process in the organism. Adventure, creative achievement, all of the higher order processes which move individuals towards greater complexity and differentiation are embraced within the scope of the homeostatic principle so conceived . . . We must consider the homeostatic principle as serving a preservative function and hence acting in the interest of life and in opposition to what Freud called the repetition compulsion, which tends, in biological terms, towards death . . .

"It is my contention that if this concept [of homeostasis] is to achieve its fullest usefulness in psychology . . . it should be used as an index of the current balance of the life and death forces in the organism, forces which are reconciled and 'bound' within each new homeostatic balance of the personality system. In this sense homeostasis becomes an indispensable auxiliary construct to a theory of life and death instincts . . ."

Dr. Menninger discusses the applications of theories of cybernetics and feedback to the mechanisms of personality government as outlined by Freud, and states that in order to make the homeostatic theory applicable not only to psychological wants but also to the organism's relation to the whole of organic life, it is necessary to consider the "pressures" or forces which the ego must mediate in order to maintain psychological and physiological homeostasis.

"All behavior, therefore, that of organs and that of the whole organism, may be defined as a con-

tinuous attempt to preserve organismic integrity by homeostatic restorations of disturbed equilibrium. And we may redefine homeostasis, or the steady state . . . [as] the integrated operations of all the homeostatic partial systems, psychological and physiological . . . which comprise the total personality. We can define it as that state of balance striven for by reconciliation of the various demands, operating upon the total organism, whereby a maximum satisfaction is achieved at minimal costs, in a variable environment. Effecting this reconciliation, maintaining this physio-psycho-sociological balance, is the *chief function of the ego.*"

Dr. Menninger devotes a number of pages to the technical documentation of this concept of homeostasis in psychology, of which it is his thesis "that one can continue to follow this process, observing that as the threat of disintegration becomes greater, the regulatory functions of the ego can be increasingly taxed and are obliged to resort to increasingly radical and costly expedients." —*E. B. Sellon*

The Challenge of the Viruses

THE structure and function of the smallest living things are discussed by Dr. Ernest C. Pollard, Professor of Biophysics at Yale University, in "The Physics of Viruses," published in the December, 1954 issue of *Scientific American.*

The author reviews the process by which the bacteriophage attack the host bacterium. "On the surface of the bacterium are a set of electrical charges, distributed in a pattern which constitutes part of the bacterium's personality. On the 'tail' of the virus is a complementary set of charges distributed in a similar pattern . . . When the end of its tail comes within the field of force of the bacterium's surface, the two are pulled together and held tightly. Now if the temperature is high enough, an enzyme in the virus's tail goes to work to clear a hole in the tail and in the wall of the bacterium. Through the opening the inner substance of the virus, which must be long and thin in molecular shape, begins to move into the bacterium."

It is only after the essential part of the virus gains entry into the bacterium that the active stage of the life history of the virus begins. "In a very short time—a matter of seconds—the virus substance compels the host bacterium to halt its own growth and switch to manufacturing parts for new viruses . . . Finally, at the end of about 20 minutes, the bacterium's cell wall bursts open and about 300 full-fledged virus particles are released into the surrounding medium."

Dr. Pollard describes the appearance of some of the viruses as revealed by electron microscopy. Then he explains the work of himself and others in which the virus particles are probed with energetic radiations from a cyclotron. The bacterial virus has several different properties that can be influenced by ionizing radiations. Assuming that these properties reside in different-sized units within the virus, and expecting the largest units within the virus to receive the most hits, the relative sensitivity of the properties to bombardment would give a measure of the relative sizes of the areas in which the properties reside.

It was shown that the most sensitive property of the virus is the ability to reproduce in bacteria, next is the ability to kill bacteria, then in order of decreasing sensitivity come the abilities to interfere with the growth of another virus, to attach to a host bacterium, to combine with antibody and to attach to glass.

"It was found that the region responsible for infectivity corresponds to about one-fifth of the volume of the virus. This unit must be long and thin, which means that it must be coiled up in some way. The unit carrying the killing property is apparently smaller, and the unit that can cause interference, still smaller."

Studies using ultraviolet light to probe viruses suggest that most of the property of infectivity resides in the virus's nucleic acid with little of it connected with the protein. The property of reproduction appears to be regulated by nucleic acids alone. "The ultraviolet studies, telling something about what viruses are made of, and the deuteron studies, disclosing their sizes and shapes, obviously should provide many valuable clues to biochemists and microbiologists who are investigating life at this fundamental level . . .

"As in all other applied branches of physics, the investigator must give up a purely physical approach and lose himself in the whole biological problem. He must learn to think not merely as a physicist but as a broad scientist. If he does this, he will find great interest and challenge in the viruses. He will feel the excitement of testing the value of his beloved physical principles in fields where they have never before been applied." —*Ruth Lofgren*

The Price of Specialization

DR. Conway Zirkle of the Botanical Laboratory, University of Pennsylvania, discusses "Our Splintered Learning and the Status of Scientists" in the April 15, 1955 issue of *Science.* A tremendous volume of scientific papers is published each year. As we all know, we attempt the solution of keeping up with ourselves by dividing up the task, by our becoming specialists, and this means limiting our individual competence and interests. The effective specialist must learn more and more about more and more, learning to the very limit of his capacity, because the sum total of our knowledge of all-important disciplines is increasing at an unprecedented rate, and so far it shows no symptoms of slowing down. "If the specialist keeps up in his own field and understands what his neighbors are doing in adjacent fields—and all of this is necessary if science is to advance—he will clearly have little

time or training to investigate or understand what is going on in more distant pastures. Thus, the price the specialist has to pay for his professional competence is often an all-encompassing and, sometimes, a very startling innocence."

The author says that perhaps the result easiest to identify is the slowing down of the progress of science itself. "When the data necessary for a scientific advance are scattered and the logical connections between the individual pieces are obscured, the potential advance is simply not made. Important progress —progress in basic theory—is possible only when the raw facts can be collected and organized; only when they can be brought together into some one receptive mind. As long as they remain scattered in the minds of different specialists, the theory remains undiscovered." These conditions existed, the author continues, long before our present division of labor, but as specialization advances, the conditions get worse.

The price the specialist pays for his professional competence is very high. "But the price that society pays for the unintegrated state of its knowledge is much higher, and society has no compensations whatever. I do not mean to imply that society will meet disaster unless the millions of facts recorded in the millions of scientific contributions are organized and made available to all. The lack of integration is on a much more fundamental plane. Even the basic concepts and verified generalizations of science are scattered, and many obstacles other than their number and complexity stand in the way of their proper integration. Much scientific knowledge is hostile to some of our best-loved oversimplifications, and this knowledge, of course, will not be welcomed. When unwelcomed facts are scattered, they are much easier to avoid since we can deflect our minds from them at the first hint of their presence and before we have to face the implication of their meaning. For a long time we have had well-tested ways of disposing of facts and ideas we do not like, and we do not hesitate to use them. A partisan mind has undoubtedly been standard human equipment for the last million years. It is, and probably always has been, standard mammalian equipment. The partisan mind is one of the most effective of all isolating mechanisms. It establishes the vicious, little personal censorships that segregate us into groups and keep our information scattered—such censorships that keep us from reading certain books and periodicals that present unwelcomed facts."

The author recognizes that a complete integration of all human knowledge is impossible. It would involve a great deal of painful re-education. "Officially we are in favor of the truth, no matter how disconcerting it might be, but we do not feel the need of going around looking for trouble. Perhaps, without admitting it, we are convinced that the truth that, proverbially, will make us free, will, at least temporarily, make us unhappy." Dr. Zirkle does not try to list all the impediments to a proper integration of human knowledge. "We have become so accustomed to viewing the universe in splintered bits that many of us really assume that it has a cellular structure and that each cell can be treated conveniently as if it were a pigeonhole."

Of serious concern is society's inability to utilize fully the data that are now accumulating so rapidly. "Decisions on the national level frequently have to be made suddenly, and those who act on the higher levels have to take calculated risks. Practically no individual is equipped for such a task, and we have learned to substitute small groups for individuals when crucial decisions have to be made—such groups as a cabinet or general staff, or even a research team. But all too often, when fundamental theory is involved, serious gaps of information appear in the collective knowledge of the group. Sometimes the knowledge that could fill these gaps is simply lost in the vast fund of our undigested learning, sometimes it is excluded by partisan thinking or by the human desire to evade what is complicating. Whatever the cause, the effect has been an inability to focus all the relevant data on the questions that so vitally concern our national well-being." —*Ruth Lofgren*

The Mystery of the Living Cell

"The Cell as a Structural Unit," by Dr. George A. Baitsell was reprinted (from the *American Naturalist,* 74, 5-24, 1940) in the January, 1955 issue of *American Scientist* on the occasion of the author's retirement as Editor of the latter journal.

The synthesis of urea in 1828 showed that organic chemistry was merely a greatly complicated inorganic chemistry, that the difference between compounds formed in living organisms and those existing outside the living organism was not one of *kind* but of *degree of complexity.* Year by year since then the boundary wall between the chemistry of life and non-life has been repeatedly shattered. "As a result," Dr. Baitsell says, "it is now apparent that the plan of organization exhibited in the living world, with the cell as the basic unit, does not differ intrinsically from that exhibited by inorganic materials, but is a plan which has become amazingly elaborated and of extreme complexity.

"The phenomena characteristic of life are only possible when a tremendously complex association of certain elements is present. But the materials used in the life stuff, protoplasm—the atoms of carbon, hydrogen, nitrogen, oxygen, sulphur, and various other elements—are the same in living materials as elsewhere."

The author reminds us that it is important to inquire whether the fully established facts of organic structure give any grounds for bringing cellular organization, which is almost universally associated with the living organism, into direct relationship with the structural patterns of the elemental materials from which it is built.

"May it not be possible that the cell is essentially a protoplasmic crystal in which an almost infinite number of protein molecules, beginning with the genes in the chromosomes, are associated in a specific ultramicroscopic pattern characteristic of a particular type of cell? In such a condition independent protein molecules are not present, but all are organized to form the complete cell unit exhibited in the crystalline pattern of a specific type of protoplasm.

"In a very real sense, therefore, the cell may be regarded as a molecule of protoplasm; the least amount of this lifestuff which will exhibit the characteristics of the living state, just as a single molecule of sugar or hemoglobin is the indivisible unit of these substances."

The basis of separation between life and non-life is dependent on the *degree of complexity* rather than on a difference in kind, because, as the author points out, the same elements are used in both domains, and they must conform to the same elemental patterns. There must be a graded series from the simplest substance in the inorganic world to the most complex patterns of living substance.

"Finally, there is the possibility that a living organism is something more than the sum of its parts. Such being the case, it is not to be expected that 'continual fragmentation will of itself necessarily reveal the true inner meaning of life processes.' Ever since the establishment of the cell theory, living phenomena have been centered in the cell, but now it is evident that the virus and phage particles, far below the realm of cellular organization, exhibit certain of the phenomena inseparably associated with life at the cellular level."

Dr. Baitsell concludes with two very challenging questions. "Can it be established that the virus protein molecule is the ultimate and indivisible unit of life? Is there not the possibility that there is something deeper and more fundamental than cells and molecules that contains the key to the mystery of life, some as yet undiscovered common factor which underlies all living phenomena and which, in its effect, might be compared with the molecular theory that brought the diverse phenomena associated with the solid, liquid, and gaseous states of matter into a unified whole?" —*Ruth Lofgren*

Social Implications of Atomic Energy

For those who are concerned with integrating the fact of the nuclear weapons into their moral and political philosophy for the future—and certainly our thinking as it applies to international relations cannot go unchanged—the core of serious thought and discussion on the subject is to be found in the *Bulletin of the Atomic Scientists,* published by the Educational Foundation for Nuclear Science, Inc., 5734 University Ave., Chicago 37, Ill. Being written, in the main, by and for atomic scientists, discussion centers about a core of informed opinion. Evidently to be informed is also to be alarmed. The magazine, "for science and public affairs," also carries on some discussion of contemporary questions in the philosophy of science.

A magazine of similar aim is published in Britain for the British Atomic Scientists' Association, by Taylor and Francis, Ltd., Red Lion Court, Fleet Street, London EC4. The Atomic Scientists' Association is "an association of scientists whose work has given them special knowledge of the consequences for the world of the use and misuse of atomic energy." Every two months the *Atomic Scientists' Journal* is published "to make known the facts about atomic energy and its implications . . ."

In connection with this subject the history of the development of the hydrogen bomb is of interest. The reader is advised to beware of a "sensational" book written by two journalists, J. Shepley and C. Blair, which, according to those in a position to know, is full of calumnious and misleading distortions (see review by Gordon Dean, *Bulletin of the Atomic Scientists,* November, 1954). Dr. Edward Teller, in *Science,* Feb. 25, 1955, attempts to set the record straight. In so doing, in sharing the credit with many other scientists who also made important contributions, he illuminatingly portrays the complex, co-operative, interrelated, and unpredictable nature of present-day progress in science.

The relationship of nuclear scientists to society as a whole has become a chief problem of the day. Besides questions of moral obligation and culpability regarding the invention and application of the great weapons, serious practical problems arise out of the conflict between the secrecy necessary for national security, and the freedom of communication necessary for rapid scientific progress. To complete the circle of confusion, rapid scientific progress is essential to national security. Furthermore, the work of scientists is being hampered by the psychological atmosphere of conflict, inconsistency, and defamation which has been the result of the security dilemma.

The scientists are gradually getting the idea communicated to the public that all scientific secrets are temporary secrets only, therefore that rapid scientific progress is even more fundamental to national security than secrecy, and that security programs must be considered in that light. The main issues were nicely brought to a focus a year ago in the Oppenheimer case, and the transcript of the hearings ("In the Matter of J. Robert Oppenheimer," transcript of hearing before personnel security board, April-May 1954, available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., 993 pp., $2.75) is rewarding reading for anyone who has the patience to sort out the worthwhile opinions from the unavoidably large amount of trivial exchange and procedural detail. The highlights of the public discussion of the case are noted and reviewed in the *Bulletin of the Atomic Scientists* in the issue of December, 1954. —*Ray W. Jackson*

NEWS AND NOTES

On March 28, the Board of Regents of the State of New York made a demand upon teachers. It occurs in a statement urging the schools of the State to pay attention to the teaching of the moral and spiritual heritage of America by the intensive study, in frequent periods, of our historical documents which deal with "liberty under God, respect for the dignity and rights of each individual, and devotion to freedom." Such a directive is not new. But one phrase is perplexing. Moral and spiritual values are to be developed *"through all activities and lessons of the school day,"* and particularly by the good example of the school staff.

The Regents are, in effect, making a *new* demand on the teachers of the State. In November 1951, they recommended that every school day be opened with a non-sectarian prayer, which has since become known as "the Regents Prayer."

In this present (1955) statement, the Regents have been at pains to say that "teachers will be mindful always of the fundamental doctrine of the separation of church and state and careful at all times to avoid any and all sectarianism or religious instruction which advocates, teaches or prefers any religious creed."

These two directives—(1) teach piety; (2) do not disturb agnostics—are now to govern "all activities and lessons."

We welcome this statement as a clear recognition of the evils of the *exaggerated* secularization of education which has prevailed for so long. It may signalize a conviction that an attempt to make education strictly existential and operational ultimately fails in respect to character formation because it lacks depth. It is a recognition that education in skills and in breadth cannot result in more than virtuosity. But does it constitute an admission that the character of a truly educated person can only be developed in reference to the metaphysical ground which is the only valid frame for all things and all men's lives? If this is the Regents' intent, we may be grateful indeed. But if that is the intent, then how is it to be carried out?

The Regents do not provide an answer. We venture to suggest that there *is* one, that it is simple, and that it is indicated in the very same Founding documents which the Regents want to have studied. No one can object to the teaching throughout the school system of *the laws of nature*. If then, arithmetic, art, sport, grammar and everything else were taught in terms of the laws of number, the inescapable principles of art, the rules of the game, the laws of language, the child would be studying the laws of nature—including human nature—and he would learn that the teacher knows and obeys these laws. (Hence the teacher would be an example, as the Regents direct him to be.) When the child later gets into chemistry and physics, biology and psychology, he will find more laws. They will always be more examples of how we know laws, and they will always be laws to be obeyed and to be used harmoniously in order to be free. No man is free by merely saying so. Some Congressional committee may say he isn't. But when *all concerned* (including *future* Congressmen) know natural law and obey and reflect it in all they do (including legislation) all will be free in the degree in which they exercise the right with the knowledge.

We recommend to the Regents that they *first* make sure that the study of natural law is the core of all education in New York State. When everyone knows all that can be known about natural law, and about our means of knowing, the Regents can be sure that the individual will take the next step by himself. This surely is what Jefferson meant when he wrote in the Declaration of Independence "the laws of nature and of nature's God." Is it fair of the Regents to urge the schools to use prayer if they do not help to make sure that the schools teach the laws of nature?

Surely it is time that the teacher education program of the State of New York is revised to ensure that these directives have effect in the *only* way they can be given effect in a secular system?

We may be grateful for the insight which leads the Regents to say that education for character cannot succeed without reference to the religious, the moral, ethical, metaphysical and philosophical implications of subject matter. But how is this to be done? Are the Regents ready to inquire into this question and give the teacher guidance, so that the teacher can teach in earth science, mathematics, sociology and all else, "the laws of nature and of nature's God?"

The time has come when both "church" and "state" must re-think the whole matter of the relation of reason to the school child's moral and spiritual heritage. Both parties must begin in humility by recognizing the harm that has been done to millions of human lives because of the ridiculous confusion of the moral and the spiritual with "the Church" on the one hand, and the equally ridiculous and presumptuous contention by "the Church" that it has a monopoly on the "moral" and the "spiritual," on the other hand. In this confusion, we have succeeded only in "throwing the baby out with the bath water" —the religious and spiritual life of untold numbers has thus been stunted; education has been made shallow and relatively meaningless; and the public morals and the spiritual heritage of "the state" have been surrendered to operational expediency.

Integrated education, based upon concepts, will reveal that "all activities and lessons of the school

day" (to quote the Regents' statement) will reach to moral, ethical, philosophical (and spiritual) conceptual roots and insights. We have pointed out repeatedly that those forces which have made this country and our way of life strong and successful were released by the concept of "Nature's Law and Nature's God" upon which the founding Fathers concurred in writing our basic documents. We are therefore heartened to see these basic documents listed by the Regents. We are grateful for their comment upon the Declaration of Independence: " 'All men are created equal' is the basic principle of the brotherhood of man and 'endowed by their Creator with life, liberty, and the pursuit of happiness' is recognition of the fatherhood of God and that these most precious rights come from the Creator and not from kings, princes, or other men." Perhaps now the schools of New York State can begin to solve the problem of "how to teach citizenship." Perhaps now a start can really be made toward lifting the sights of school children as regards their concepts of man, of society, and of man's place in a cosmos which can now be referred to as having more than mechanical and material aspects. Perhaps, thus belatedly, teachers and schools can, by free reference to the metaphysical, moral, spiritual Ground, begin to help pupils integrate relatedness, meaningfulness and order into the data that they impart.

We note that the Regents' suggestion cited as an example that sports and games "may be used to build a sense of fair play, a willingness to lose a game rather than cheat, a desire to do to others as you would be done by." To us, this seems a reiteration of the professed goals of all coaches, athletic directors, and recreation leaders. We recommend to the Regents and to these worthy sportsmen that they supplement these noble concepts with a few others, which can not only be validated by our spiritual heritage but also by modern science. These we suggest, are: freedom (to play, to do, and to win) is a function of order (the rules of the game). The fundamental "Rules of the Game" of Life (and all of its phases) derive from the "Laws of Life" which, in turn, are the rights and responsibilities which are our endowment under "the Laws of Nature and of Nature's God." Discipline (as skill, as technique, both to do and to know) is "discipleship" to, or coordination with, natural law and organization.

Our thanks go to the Board of Regents of New York State for proclaiming that insight is a function of every subject taught. We trust that the teachers and administrators of the schools of the state will now accept this recommendation as the opportunity to teach in depth as well as in breadth.

—F. L. Kunz

We have received two copies, Volumes I and II, of the *Journal of Psychotherapy as a Religious Process,* which, published once a year, serves as the organ of the Institute for Rankian Psychoanalysis, Inc., 1062 Harvard Boulevard, Dayton 6, Ohio. (Annual subscription, $2.00.)

The program is described as follows: "The Institute believes that all personality and neurotic difficulties begin in the soul of man and not in his body or mind. Therefore, their cure is a spiritual problem and psychotherapy is a religious endeavor. One significant aspect which differentiates this approach from so many of the purely scientifically oriented therapies is the reliance of the therapist on spiritual forces within the personality to effect the healing of the sick self."

In the current, January 1955, issue, there are articles on "Personalistic Psychoanalysis as Symbolic Knowledge," by Count Igor A. Caruso, "On Depth-Psychology and Salvation," by Wilfried Daim, "A New Concept of the Psychotherapist's Role," by Alphonse Maeder, and "Reflections on the Work of Jung and Rank," by Martha Jaeger. We quote briefly from two of the articles to indicate the philosophical position:

Dr. Jaeger writes: "In considering this whole subject, the similarities [between Rank and Jung] appear so profound and real that it would take more than a brief article to even touch upon them. Both men were pioneers in breaking away from the mechanistic and intellectual approach. Both were profoundly interested in the individual, not as opposed to his social group but as a creature evolving out of the social matrix, who possesses the power of his own re-creation. In other words, they envisaged the human psyche as an autonomous dynamic entity with both historical and spiritual content. This was the most profound break with Freud that both men made . . . In the works of both men the phenomenon of the soul is faced in all its manifestations . . ."

In "A New Concept of the Psychotherapist's Role," Dr. Maeder says, ". . . man is not only a product of nature, as are plants or animals, but a creature of a higher order whose spirit is linked to the universe and to God.

"Primitive medicine men and their successors, the priest-doctors, at first operated with a dim awareness of this fact which later became a clear knowledge of such connections. But today science by its analysis and consequent fragmentation of knowledge has lost sight of these relationships. Yet the modern theory and practice of psychotherapy, as well as a new knowledge of the totality of man, have burst the narrow confines of the merely biological, psychological or sociological, to give us a correspondingly comprehensive view of man. From this new viewpoint conscience, faith and prayer, forgiveness of sins and love, are no longer referred and reduced to scientific categories, nor even disposed of as illusions, but are again recognized and acknowledged as realities."

Those who are interested in the level of thought in which the authority of physics with respect to the objective world is conjoined to the higher levels of biology and psychology, directed to the opposite pole of human experience, will find this *Journal* worthy of note.

REVIEWS

Scientific Philosophy

NEARLY everyone in higher education knows that the special problems of our times are posed in two forms:

They are, first, the changes introduced by technology. These have and are transforming the whole business of living and they have not been subjected to a control that would make them lead for sure to the enrichment of the soul. Instead they tend to physicalism in many forms, to the sensate.

The other aspect of the problem is the dislocation of knowledge (and the need to reintegrate it) coming from the very same scientific thought which has led up to the technology.

The latter is obviously the main business of teachers. It carries them into deep waters. But if, as a society, we are to be led "beside the still waters," then the teacher must plunge in.

Causality in Natural Science by Victor F. Lenzen, Professor of Physics, University of California, Berkeley, is literally indispensable. (Charles C. Thomas, Publisher, Springfield, Illinois, 109 pages, bibliography and index, $3). For without technicalities, it traces the major problem in philosophy through the entire range of its occasions, dealing with the nature of causality, the inescapability and the character of the principle, its cognition, character in classical physics, in biology, relativity and finally in quanta.

The volume is a triumph of clarity, comprehensiveness and coordination. Thus students of natural order and of modern philosophy cannot do without it. The volume is one of a series under the general title "American Lectures in Philosophy," supervised by Dr. Marvin Farber, Department of Philosophy, University of Buffalo, Editor of the *Philosophical & Phenomenological Research Journal*. The other titles thus far issued are *Emotions and Reason,* by V. J. McGill, Associate Professor of Psychology and Philosophy, Hunter College, and *A Good and A Bad Government,* According to the New Testament, by Jean Hering, Professor, Protestant Theological School, University of Strasbourg.

We are greatly indebted to writers, editor and publisher for a truly distinguished enterprise.

—F. L. Kunz

How Children Learn

PEGGY Brogan of Child Education Foundation and Lorene K. Fox of Queens College are the authors of an exciting new book entitled *Helping Children Learn*: A Concept of Elementary-School Method (World Book Company, New York, 1955, 380 pp., illustr., index, $4.00).

"This book is an invitation to view, through the eyes of children, the learning environment in which their personalities are shaped. It considers the many ways in which individual children and individual teachers can combine their resources to shape that environment."

The easy, conversational style of the book with its many true-to-life experiences makes you feel that you are actually visiting classes and discussing educational philosophy with the authors. The main ideas are set off from the text in large type and are reinforced by many well-chosen illustrations. Quotations from recognized authorities on topics pertinent to the theme are spaced throughout the book. It is divided into seven chapters as follows: (1) Required conditions for learning, (2) Skilled communication is power, (3) Arithmetic works for children, (4) Children can learn to use science, (5) Using our cultural heritage, (6) Learning to organize movement—physical education, and (7) Living together creatively.

The following quotations have been selected to present some of the important ideas from the book. Space does not permit us to include samples of the charming experiences.

"Since children are learning all the time, in whatever circumstances they find themselves, required conditions for that learning must be described in terms of *what* is to be learned. Our democratic way of life demands that children learn those things which will make them willing and able to take on, in increasingly mature fashion, the business of their world.

"This important process of learning calls for the following interrelated conditions, the absence of any one of which is a threat to the survival of a democratic people." Children need to live in a community (1) that recognizes the importance of self-selection in learning, (2) that recognizes and provides for all of their biological needs, and (3) that needs them.

"The school must recognize the social nature of language. Our concepts about people and how they learn have changed, too. Even if we could have our earlier, more homogeneous, communities again, we could not assume that children would acquire the language skills in one situation, and then learn how to use them in another; or even that all children would learn the same thing from a given situation. People are *whole* beings, and they are social beings. There is no such thing as a 'reading self' that can be summoned up for the school reading period; for while the *whole* child is learning to read, his social nature may keep right on absorbing important learnings about himself in relation to other people. . . .

"Too many of us teachers tend to think of the number system itself as a set of memorized rules, the forgetting of any one of which means incompetence or inaction. To us, these rules are someone else's discoveries, to be 'taught' at various intervals during our schooling. We do not realize that the relationships are *in the number system* itself and are always available to any who would use them. We focus instead on these verbal rules that always seem to be locked up in desk drawers or printed in courses of study.

"Three major approaches have influenced the development of elementary science curriculums. This does not necessarily mean that there are but three specific approaches, one and only one of which is to be found in a given school or classroom. It means, rather, that there are changing and conflicting conceptions of science in our time. This conflict over the changing role of science in society is naturally reflected in the schools." Children may learn science primarily as a body of information,

primarily as a method, or they may learn science in a wider frame of problem-solving. "This third approach is in accordance with more recent concepts about the role of science in the affairs of people. It recognizes that science exists in a social context, and that the knowledge and skills of science can and should be used to solve social problems. Such an approach assumes that scientific discoveries involve social responsibilities. . .

"Their very nature helps children to use science. Whatever the program, it is not the schools that give children their *start* in science, nor their bent toward experimentation. From birth, as newcomers in a world already organized and functioning, young children *have* to investigate their environment to find out what it is like and to learn to feel at home in it. This early exploration into their world of nature and people and things is the role of children—it is their way of learning and growing.

"Whenever a group of people live together, the problem of how to encourage disciplined action from individuals arises. Children learn most efficiently through the kind of activity that challenges them. It is important therefore that they do not associate discipline with 'sitting still,' 'being quiet,' 'doing nothing.' They must see disciplined action as an integral part of activity."

Anyone interested in children and the future of our way of life will find this book rich in insights and optimism and well worth reading.

—*Ruth Lofgren*

The Ideas of The Great Book

EACH generation, for many centuries, has been told by its elders that the Bible stands above the wrecks of time as the quintessence of the truths by which men should live. Each generation has, to a greater or less degree, done some "Bible study" and has passed years in relative quiet in "Sunday School" or "Bible School." Many, many of us concur in a reverential view of this tap-root of our culture, yet there are actually precious few who can turn to the Bible with precision and sureness for "knowledge of God's truth."

We have been waiting far too long, therefore, for someone to attack the tremendous task of culling and organizing the great concepts which are embedded in the Bible. At last, the service has been performed. To Rhyllis Goslin Lynip, a remarkable woman of sensitivity, insight, devotion, and scholarship we are indebted for the mobilization, in beautiful and usable form, of *Great Ideas of the Bible* (Harper & Brothers, N. Y., Vol. I, 1954, 268 pp., $2.75; Vol. II, 1955, 271 pp., $2.75).

As the author indicates in her introduction, about one-tenth of the Bible is included in the two volumes and the selections have been organized by ideas instead of being arranged by Books from Genesis to Revelation. The excerpts from the Bible are taken from the translation of Dr. James Moffatt. All of these are well-chosen and are connected with easy, beautifully- and directly-written text. The author's aim, as stated in the introduction to Volume I, is ". . . to avoid theological discussion and to emphasize those ideals and values which contribute to the building of character and to the achievement of high purposes." This aim has been admirably achieved and so has the goal which the author set herself in preparing her text: ". . . that the purpose is not to carry the thinking back to ancient times but rather to bring the great ideas of the Bible forward and plant them firmly in the middle of the twentieth century as a challenge to modern youth."

We who are professionally concerned with the methods of teaching with concepts clearly held in view welcome these volumes as great contributions to the philosophical and conceptual education of our youth for whom Mrs. Lynip especially prepared them, "modern young men and women who will have to face crucial problems in the atomic age. . . Whether they fulfill their responsibilities and measure up to their opportunities will be determined by their awareness of moral law and spiritual values, by their sense of purpose, by the quality of their religious faith." We urge parents and teachers to make these lovely volumes available to those who can do the most with them—the men and women of tomorrow.

Each volume is divided into three main sections. Volume I: The Nature of God and Man, The Meaning of Right and Wrong as Proclaimed by Old Testament Prophets, The Ideas of Jesus. Volume II consists of: Faith in God and Man (with the records of four heroes, Moses, Elijah, Jeremiah, and Paul), The Problem of Suffering, Inspiration for Great Living (Love, Prayer, and Vision). Each of these sections is subdivided into five to eight chapters which develop the section's theme.

These volumes constitute an excellent piece of research work. They are skillfully, yet lovingly done. These are truly great books which shall strengthen the power of The Great Book.

—*Harvey W. Culp*

Lucid and Organized Biochemistry

THE *Chemistry of Living Cells,* by Helen R. Downes, Professor of Chemistry, Barnard College, Columbia University, is published by Harper & Brothers, New York (1955, 549 pp., index, $7.50).

The book is an outgrowth of a course in biochemistry which has been given at Barnard College for the past twenty years. The author's experience and ability are evident in the clarity and organization of the presentation as well as in the discrimination with which biological and general chemical information has been included in order that the reader may locate the biochemical processes in their proper settings.

The Chemistry of Living Cells is divided into three parts: (1) Some Preliminary Considerations (the history and literature of biochemistry, some properties of aqueous solutions, and the structure of living forms); (2) The Organic Constituents of Cells (carbohydrates, compounds of nitrogen, the lipids, and the enzymes); (3) Intermediary Metabolism (methods used, transport systems, digestion and absorption, metabolism of compounds of nitrogen, lipids, carbohydrates, biological oxidations and biosynthetic mechanisms).

The following excerpts illustrate the author's ability to retain the integration of biology and chemistry.

"Integrated Enzyme Activity. In order to study the properties of a given enzyme, it has been necessary to separate it not only from the cytoplasmic fabric of the cell itself but from other enzymes. It might have been argued, and indeed it was, that the properties which were found under such unnatural conditions might

bear no relation to those exhibited by the catalyst in its normal environment in the cell. Fortunately this has proved not to be true. In very recent years it has become possible to examine cell material without entirely disrupting its organization. The ultracentrifuge has been used to separate into various fractions the tiny particulate elements distributed through the cytoplasm. Some of these are proving to contain whole groups of enzymes so organized that the isolated particles catalyze an elaborate sequence of chemical reactions in which the end product of one catalysis becomes the substrate of the next. This integrated activity consists, not of new and strange reactions, but of reactions already associated with known cell catalysts. That this orderly sequence of events follows a pattern previously deduced from work with isolated enzymes is one of the triumphs of modern biochemistry. . .

"Plant Hemoglobin. Leguminous plants have an almost unique place in nature in that in the presence of certain soil bacteria they are able to fix atmospheric nitrogen and thus to use it in synthesis. This reaction takes place in nodules formed by bacteria on the roots of the plants. In these nodules hemoglobin has been identified, partly by its absorption spectrum, partly by its reversible reaction with oxygen and partly by the bile pigment-like decomposition products which it forms. Up to the present it has not been possible to prove that it serves a function in symbiotic nitrogen fixation, but its localization in the nodules certainly suggests that either the plant or the bacteria make some use of its ability to store and to release oxygen."

This book is an introductory text; however, it is in no sense a "popular" treatment of the subject. The author assumes that the reader has an acquaintance with chemistry and biology. The book is rich with chemical formulae and illustrations that clarify the ideas being discussed. Anyone who has the background and is interested in the chemistry of living things will find this book to be an excellent investment.

—Ruth Lofgren

Love as a Social Force

M. F. Ashley Montagu has turned out a truly scholarly work in his new volume, *The Direction of Human Development* (Harper & Brothers, N. Y., 1955, 386 pp., Appendices, Bibliog., Index, $5.00). The book is subtitled, "Biological and Social Bases. A scientific confirmation of the enduring belief that human love is essential to all social growth."

First, let us say that the amount of work which is evidenced in Appendix C, which is his bibliography, is monumental and, of itself, is worth the price of the volume, for here the author has brought together a total of more than six hundred references, many of which are not within the resources of the large majority of readers. What is more, a great many of them are annotated or commented upon at some length by the author. The material ranges through anthropology, biology, psychology and related fields and, from this wide scope, little-known experiments on animals and humans are brought in to add to the weight of evidence which is amassed upon the central theme.

As stated on the jacket of the book, this "central theme" is "the necessary role of cooperation and affection in the life of the individual in society. This is in essence a scientific validation of the eternal belief of poets and prophets in the importance of love in all human affairs . . ."

"Cooperation" has become such a stereotyped word in our culture that it may come as a shock (and a very salutary one) to some to read a thoroughly documented chapter on "The Biological Basis of Cooperation." But this is only the beginning, for the "orchestration" of the theme continues to build page by page in such a manner that a reader who is at all inclined to research work is tempted to start shouting for aid in running down the multitude of insights and clues which are here set down.

We cannot attempt to address ourselves to any one portion of this work. All we shall say is that the author has made a signal contribution to the attack upon the most basic problem (and the greatest power) in life. Amid the clangor of the physical aspects of our times, it is reassuring to know that the still small voices of love, affection, and intimate togetherness may, in truth, be more powerful than all the "principalities and powers" and their armaments. It is even more reassuring to find, in this compendium, so much scientific evidence for this intuition. We sincerely hope that many laymen, parents, counsellors, and teachers (as well as professional social scientists and clergy) shall use this book not only to understand life better but to begin to live it better and more fully.

—Harvey W. Culp

Integration in Psychology

We have had a book in our hands for some time and have used it without sharing it with our readers. It is *Learning Theory, Personality Theory, and Clinical Research,* The Kentucky Symposium, (John Wiley & Sons, Inc., N. Y., 1954, 160 pp., Index, $3.50). This volume is a collection of eleven lectures given under the auspices of the Department of Psychology in the College of Arts and Sciences of the University of Kentucky on March 13 and 14, 1953. This symposium was held for the purpose of encouraging integration of current thought in three branches of Psychology. The result of these published papers is this provocative and useful volume, rich in much new material and manifesting a sincere effort on the part of the members of the symposium to reach common ground.

We regret that lack of space prevents more than a brief quotation to give the flavor of this excellent book:

Donald Snygg (Teachers College, Oswego, N. Y.) concludes his paper, "Learning: an Aspect of Personality Development," with these well-chosen words: "Whatever conceptual schemes we use, psychology, education, and psychiatry would all benefit from a greater use of human subjects in research, with animal subjects being reserved primarily to check the validity of hypotheses developed from the observation of human subjects in situations where there are enough courses of action to give individual patterns and idiosyncrasies a chance to show."

—Harvey W. Culp